# L19 - Utilizing the PowerMonitor 5000 M6 and FactoryTalk EnergyMetrix 2.10 for Energy Management and Power Quality Analysis

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**WARNING**

Identifies information about practices or circumstances
that can cause an explosion in a hazardous environment,
which may lead to personal injury or death, property damage, or economic loss.

**IMPORTANT**

Identifies information that is critical for successful application and understanding of the product.

**ATTENTION**

Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you:

- identify a hazard
- avoid a hazard
- recognize the consequence

**SHOCK HAZARD**

Labels may be located on or inside the drive to alert people that dangerous voltage may be present.

**BURN HAZARD**

Labels may be located on or inside the drive to alert people that surfaces may be dangerous temperatures.

# Energy Monitoring and Visualization utilizing FactoryTalk EnergyMetrix

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## Before you begin

### About this lab

Attendees will learn about how to use Rockwell Automation's Power Monitoring products in conjunction with FactoryTalk EnergyMetrix to optimize industrial customers' power and energy usage.

- **Part 1 – Logging into FactoryTalk EnergyMetrix**
- **Part 2 – Energy Management**

  Covers using Energy Management Trends and Reports to understand and take action on energy data.
- **Part 3 – Power Quality**

  Covers using Power Quality Metrics to understand and identify mitigation for power quality issues.

### Tools & prerequisites

Part 1, 2, 3 and 4:

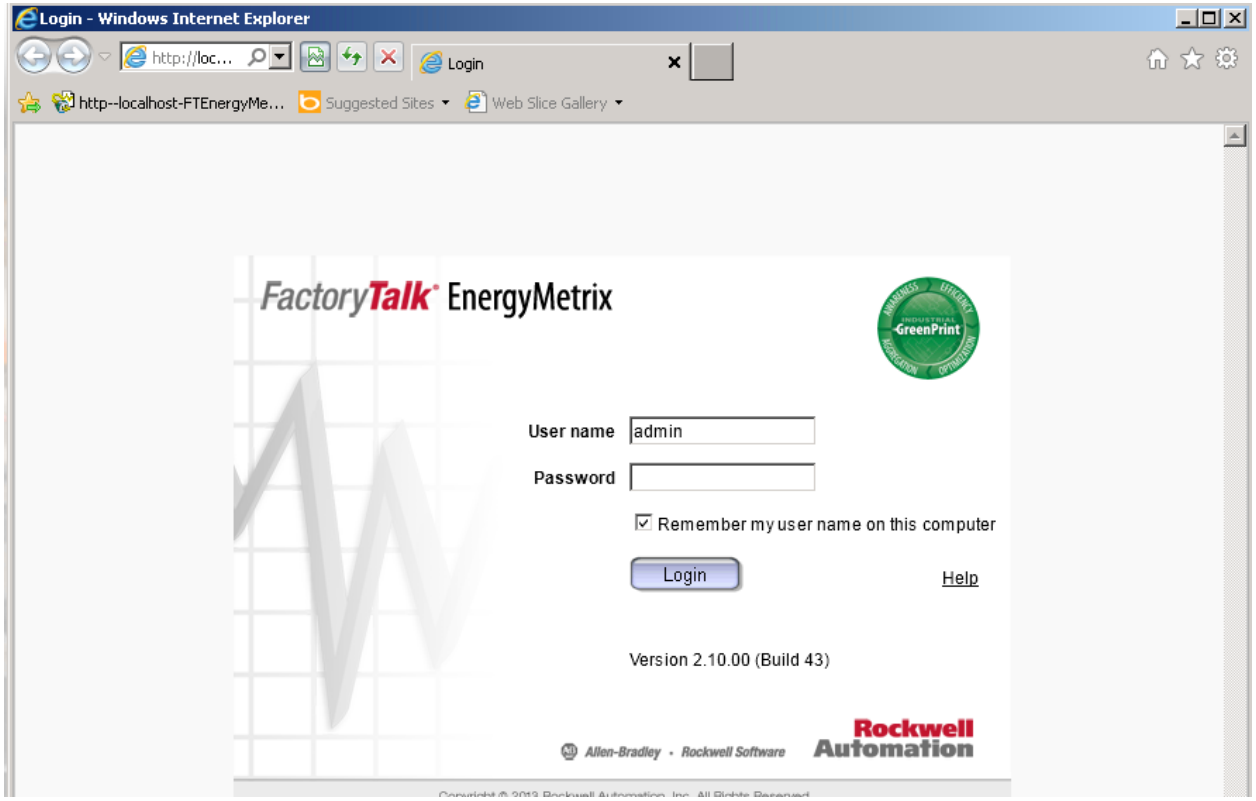
- Lab VMWare image – This image has FactoryTalk EnergyMetrix 2.10 and RSLogix 5000 V21 installed
- PowerMonitor 5000 M6 unit connected to 240V
- PanelView Component 600 Color Touch to demonstrate the Display Monitor Application (1426-DM is a C400)

**Note:** If not already running, please select and run the Lab VMWare image on your workstation PC.

## Part 1: Logging Into FactoryTalk EnergyMetrix

***Open*** Internet Explorer. The FactoryTalk EnergyMetrix login page is set up as the home page <http://localhost/FTEnergyMetrix>. Log in with user name: **admin** and password: **admin**

- This login gives you administrator access to the Efficient Industries Plant 1 domain.




- Once you log in,there are four tabs on the navigation pane. Each tab is described below.

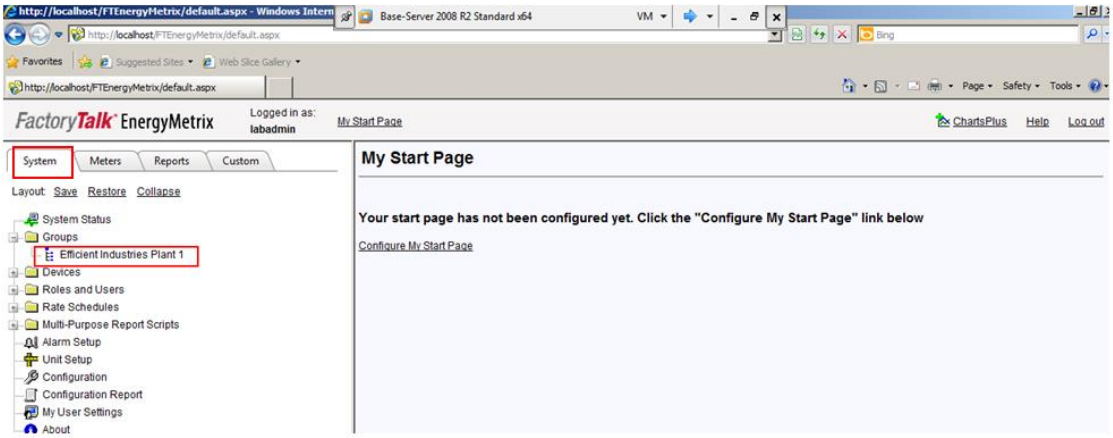
**System**: Allows Configuration for Groups/Domain (tree structure), Devices, Roles and Users, Rate Schedules, Custom Reports (Multi-Purpose Reports, My Start Page and other setups (i.e Units, User settings, Alarm sub scriptions)

**Meters**: Allows to Configure Meters and meter tags, and to view Meter data in tabular /Trend and Calendar Trend

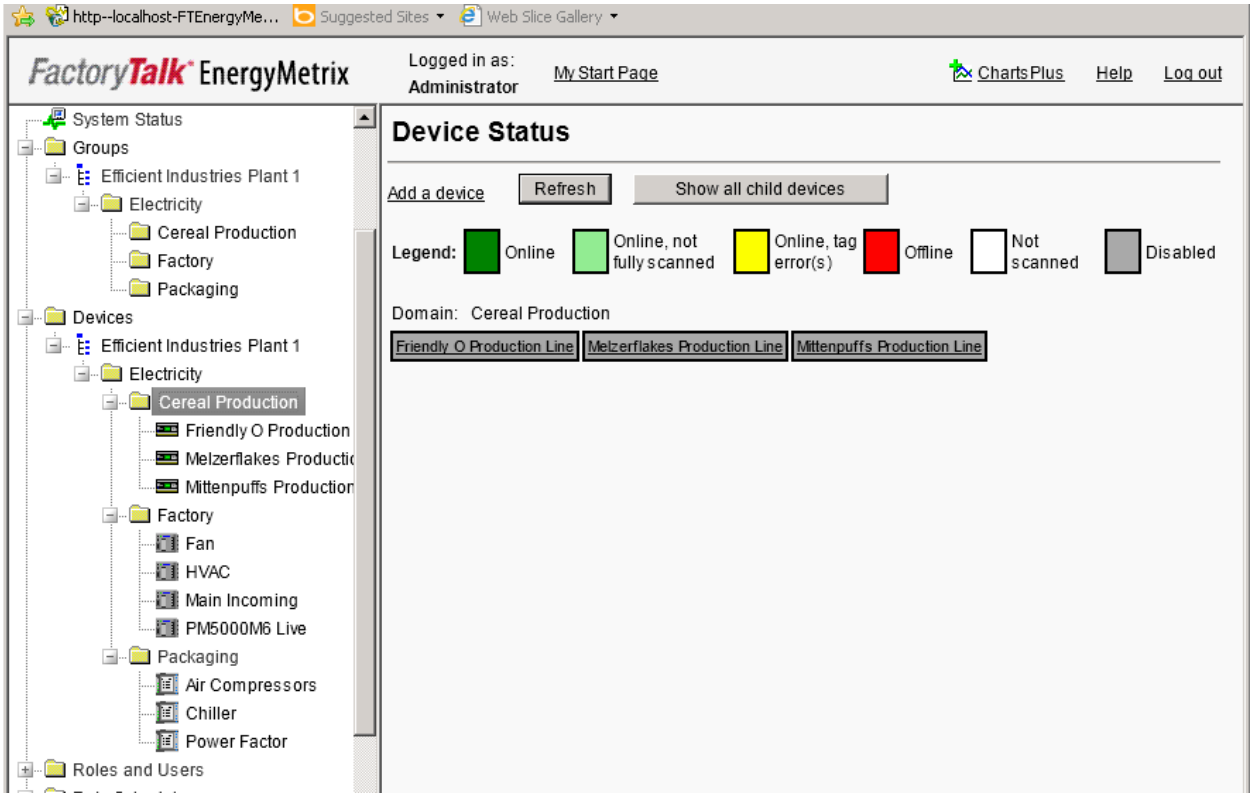
**Reports:** Allows to Configure Reports, automatic report jobs, and to generate/view reports on demand

**Custom:** Allows to Configure custom page( with URL Link, for Files (i.e. user can upload a scanned copy of Utility Energy Bill to Custom page)

> Note: The right View Pane is updated only after a sub category is selected of any given tab/(Tree Item).




- We have created all the Groups and Devices.




***The "PM5000M6 Live" device is a live Power Monitor 5000M6. The other devices are disabled.***

## Part 2: Energy Management

In this section, we work with an imaginary factory named “Efficient Industries”, which has 3 cereal production lines – Friendly O, Melzerflakes, and Mittenpuffs. We will take you through a list of scenarios to demonstrate how deploying PowerMonitors and FactoryTalk EnergyMetrix (FTEM) software helps to identify potential energy efficiency projects and demonstrate savings.

Any industrial electricity bill is typically comprised of 4 components: Standard Service Charge, Electricity Consumption (kWh), Electricity Demand (kW), and Power Factor. As a part of this lab, we will guide you through a series of steps to analyze the data and validate the savings achieved through energy efficiency initiatives. This section is comprised of four main parts:

- Viewing “Electricity Consumption” trends & Generating consumption reports
- Viewing “Electricity Demand” trends & Generating demand reports
- Generating “Power Factor” reports
- Generating “Billing” reports

### Viewing Electricity Consumption Trends

PowerMonitor devices and FactoryTalk EnergyMetrix software can be used to drive accountability and results when looking to reduce energy consumption and consequently energy costs. In this scenario, “Efficient Industries” purchased three PowerMonitor 1000s to achieve real time monitoring of electricity consumption for each cereal production line. Using the energy consumption trends feature in FTEM software, you have the ability to view the real time net electricity consumption (kWh) and net reactive energy consumption (kVARh) data from the installed power monitors. This data is greatly beneficial to check the correlation of electricity consumption with the production data and determine energy intensity per product, energy consumption across different shifts, equipment that are left ON unnecessarily during weekends, check utility billing accuracy etc.

After monitoring the electrical energy consumption over the course of the first billing cycle, “Efficient Industries “ implemented energy savings initiatives such as installing energy efficient lighting, replacing full voltage starters with drives, programming a low energy state for when equipment is not in use, and shutting off machines during non-production hours. As a result, “Efficient Industries” was able to visibly see energy and cost savings achieved from their initiatives.

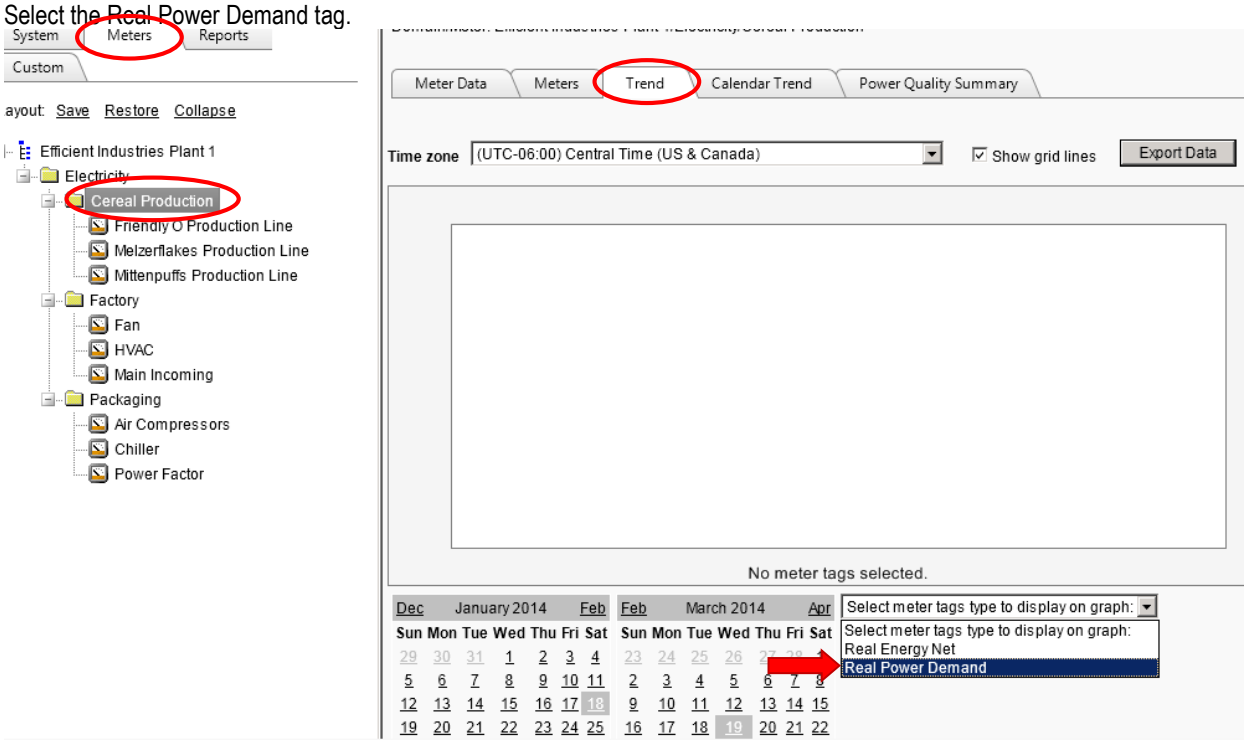
The list of steps to view the cumulative electricity consumption trends of the cereal production lines in the FactoryTalk EnergyMetrix software are described below:

**Step by Step Instructions**

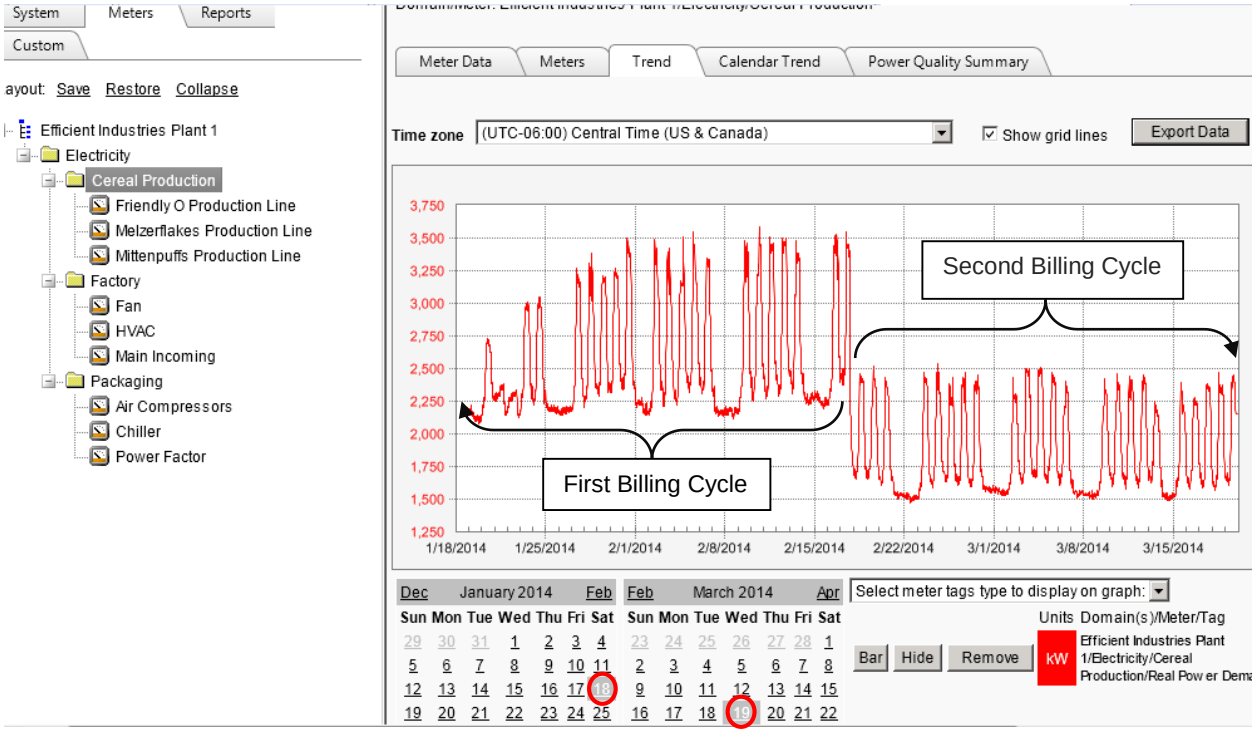
1. Click on the Meters Tab and Select the Cereal Production Group

2. Select the Trend Tab.

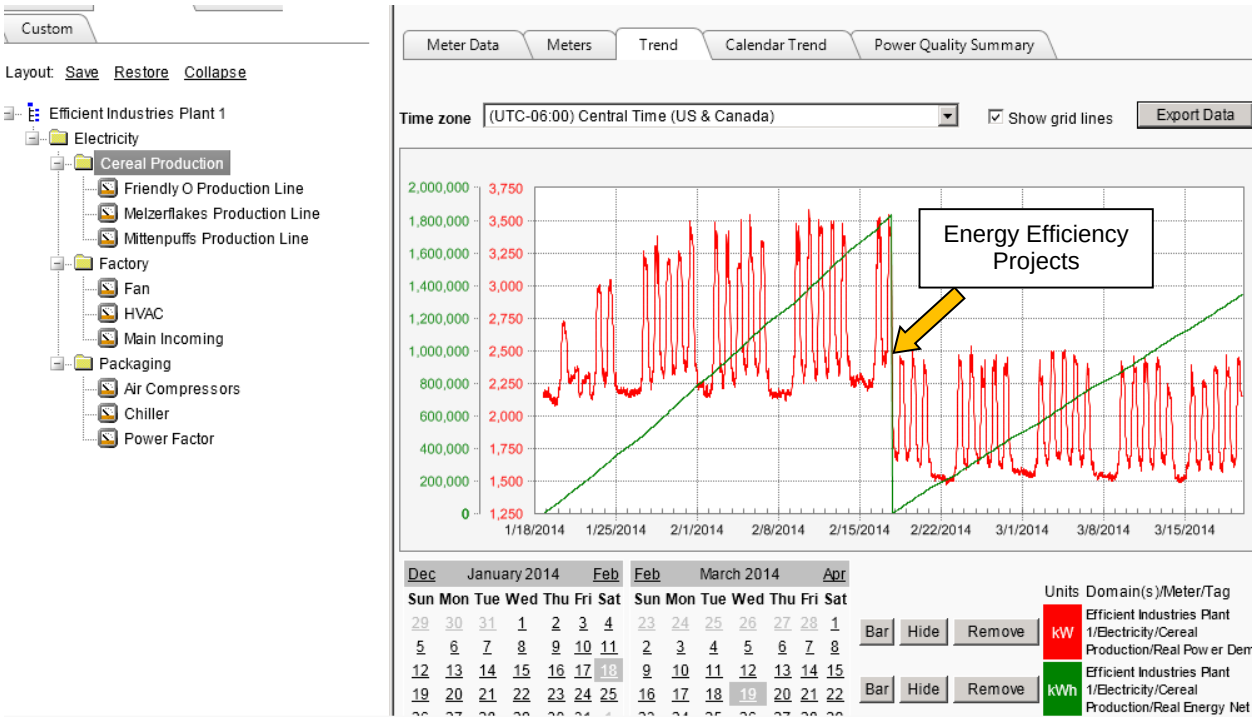
3. Select the Real Power Demand tag.



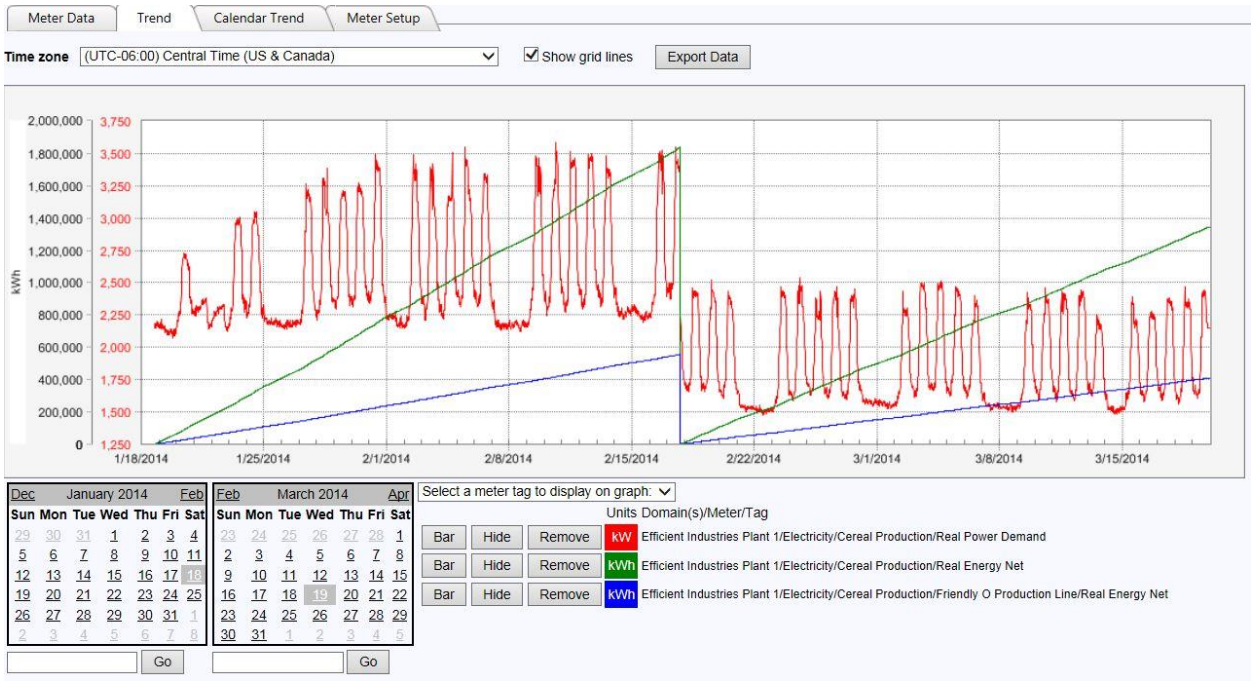
4. Change the date range from **Jan 18, 2014** to **March 19, 2014**. The aggregate electricity demand trend for all the three cereal production lines during the two billing cycles will be shown.




5. Select the ***Real Energy Net*** tag to view the aggregate electricity consumption along with electricity demand for the two billing cycles.




6. Click on “Friendly O Production Line” on the left, and select “Real Energy Net” to view the electricity consumption of this line. Repeat the same for the other production lines to view corresponding individual electricity consumption trends.



From the above trends, notice the reduction in aggregate electricity consumption level in the second billing cycle, compared to the first billing cycle. This is primarily due to the implemented energy efficiency projects such as installing energy efficient lighting, replacing full voltage starters with drives, programming a low energy state for when equipment is not in use, and shutting off machines during non-production hours.

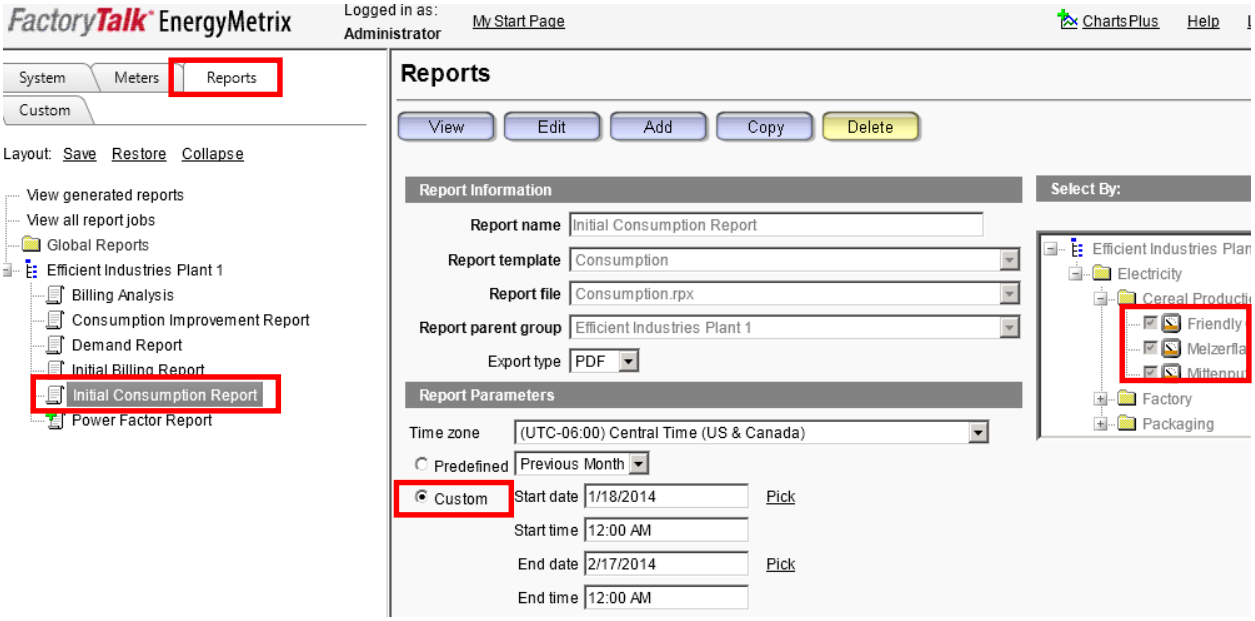
### Generating Electricity Consumption Reports

In this section, we will guide you through a series of steps to generate electricity consumption reports in FTEM software.

**Step by Step Instructions**

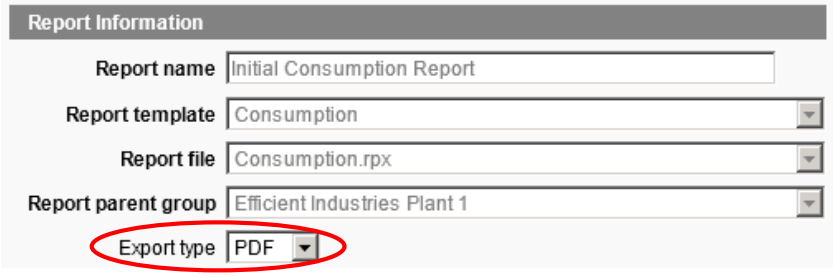
1. Click on "Reports" tab on the left navigation pane.

2. Click on a group level in the left navigation tree, and click on a consumption report. In this example, we selected "Efficient Industries Plant 1" group level and the "Initial Consumption" report. As highlighted in the below screenshot, this is a pre-configured aggregate consumption report for all the three cereal production lines.




3. You now have the capability to "View", "Edit", and "Delete" the selected report. You also have the capability to add a new report or build a new one on top of the existing report.

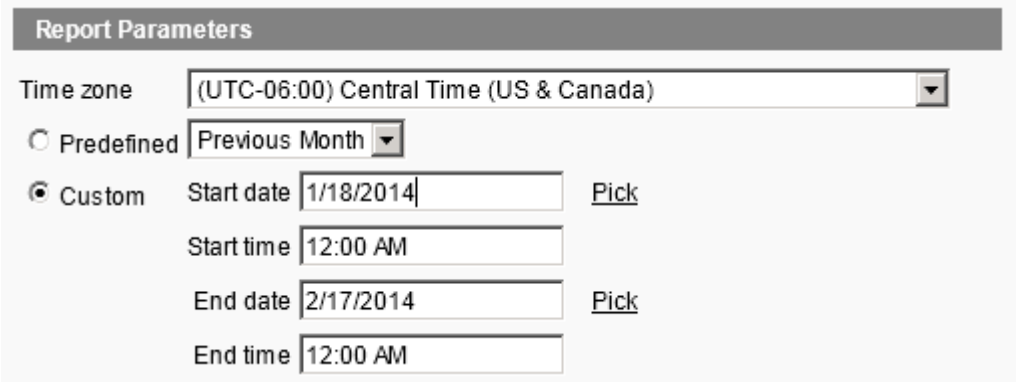
4. You can view the consumption report in various file formats (pdf, excel, html, rtf, tiff). This can be achieved by selecting the appropriate “Export type” from the “Report Information” section.




5. You have options to view the consumption report during specific time durations by selecting appropriate “Predefined” or “Custom” options under the “Report Parameters” section.

   a. By selecting the “Predefined” option, you have an option to quickly select the time duration based on standard sets such as “Previous Month”, “Previous Year”, “Year to Date” etc.

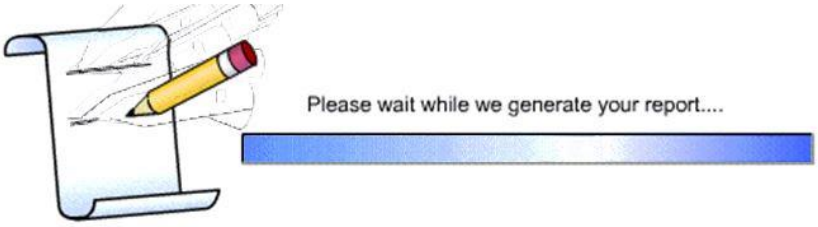
   b. By selecting the “Custom” option, you now have the capability to specify exact date and time duration during which you want to view the consumption report. In this scenario, enter **Jan 18, 2014 12:00 am** and **February 17, 2014 12:00 am** as start and end dates to view the consumption report for the first billing cycle.




6. Upon making these selections, you can click on “View” button, to view the consumption report of the selected meters.

7. You will notice an initial report generation message and then be able to view the report in the selected format.

Please note from the below screenshot that the electricity consumption for all the production lines during the first billing cycle is **1,787,314 kWh**.




FactoryTalk EnergyMetrix

**Efficient Industries Plant 1**
**Efficient Industries Plant 1**

***Initial Consumption Report*** 1/18/2014 12:00 AM to 2/17/2014 12:00 AM

**Time Zone:** (UTC-06:00) Central Time (US & Canada)

**Cereal Production (ID 4)**

**Electric**

| | Real Energy Net (kWh) |
|---|---|
| Friendly O Production Line | 541,784 |
| Melzerflakes Production Line | 891,331 |
| Mittenpuffs Production Line | 354,199 |
| **Total(s):** | **1,787,314** |

8. Change the start and end date as **February 18th, 2014 12:00 am** and **March 19th, 2014 12:00 am** to view the consumption report for the second billing cycle.

Please note from the below screenshot that the electricity consumption for all the production lines during second billing cycle is **1,291,258 kWh**.

FactoryTalk EnergyMetrix

Efficient Industries Plant 1
Efficient Industries Plant 1

***Initial Consumption Report***

2/18/2014 12:00 AM to 3/19/2014 12:00 AM

**Time Zone:** (UTC-06:00) Central Time (US & Canada)

**Cereal Production (ID 4)**

**Electric**

| | Real Energy Net (kWh) |
|---|---|
| Friendly O Production Line | 393,775 |
| Melzerflakes Production Line | 641,212 |
| Mittenpuffs Production Line | 256,272 |
| **Total(s):** | **1,291,258** |

Based on the data listed in the report, you would be able to analyze the electrical energy consumption data across different lines or areas of the manufacturing area during different time periods. From the above scenario, “Efficient Industries Plant 1” was able to save about **496,056 kWh** (difference of consumption during both billing cycles). Thus, monitoring and analyzing data would be greatly beneficial to identify various energy efficiency opportunities and also to validate the cost savings achieved after implementing these opportunities. Moreover, users can see which processes are the most energy intensive for which to focus energy saving initiatives.

## Viewing Electricity Demand Trends

What industrial energy users often don’t realize is that electricity demand charges can be as high as 50% of their utility bill. This charge is based on the highest 15 minute or 30 minute interval of electric demand throughout a billing cycle.

With a PowerMonitor 500 on their Main Line, “Efficient Industries” noticed that on Mondays at the beginning of the first shift, there was a large peak load contributing to their demand charges. Investigating more, the plant management figured out that this was happening when the operators were turning ON a majority of their heavy equipment at the same time. They realized that cost savings can be achieved by staggering their equipment start-ups and shifting them to off-peak time periods, either manually or using Rockwell Automation controllers.

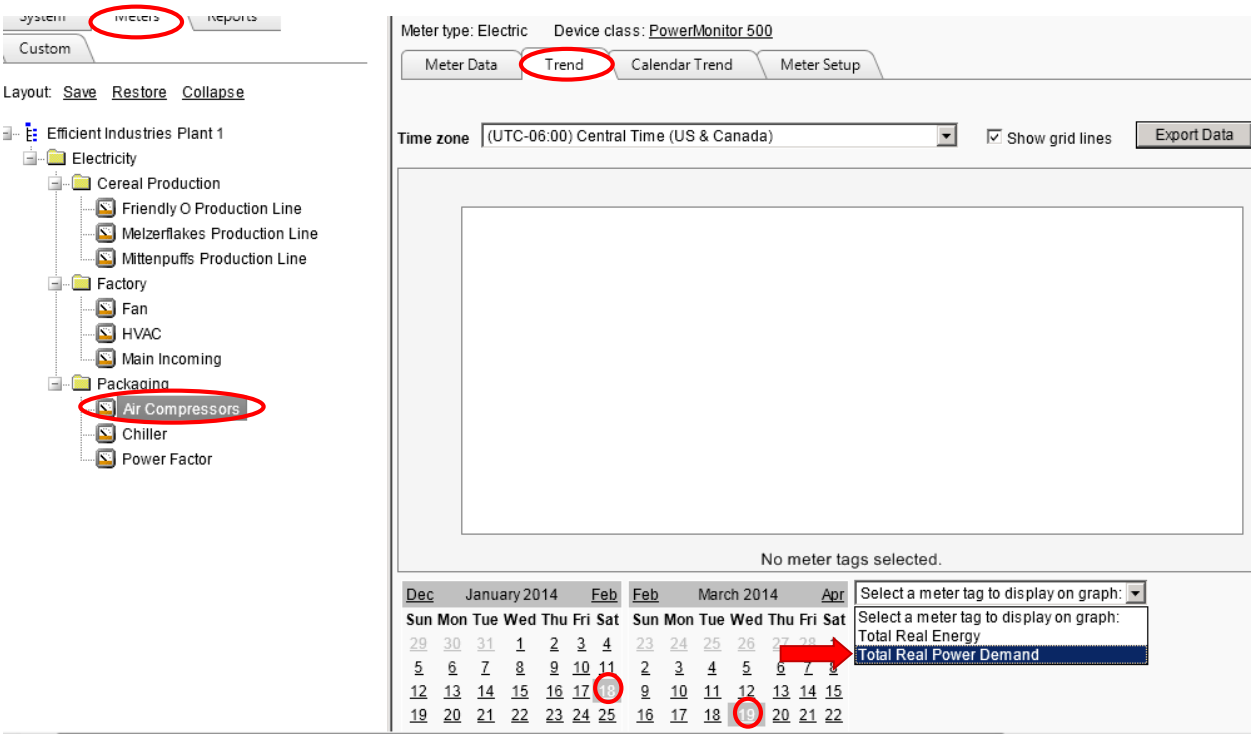
Using the energy demand trends feature in FTEM software, you have the ability to view the real-time electricity demand (kW) data from the power monitors installed across the manufacturing plant. This data is greatly beneficial to analyze the demand aspect of the utility bill, analyze the electricity demand during different shifts, develop a strategy to perform staggered startup of the plant equipment, and evaluate the utility demand response programs for better incentives.

In this below scenario, Efficient Industries "Air Compressors" line constitutes of a majority of the equipment contributing to their electricity demand. The list of steps to view the electricity demand trends of the meter installed on "Air Compressors" line are described below.

**Step by Step Instructions**

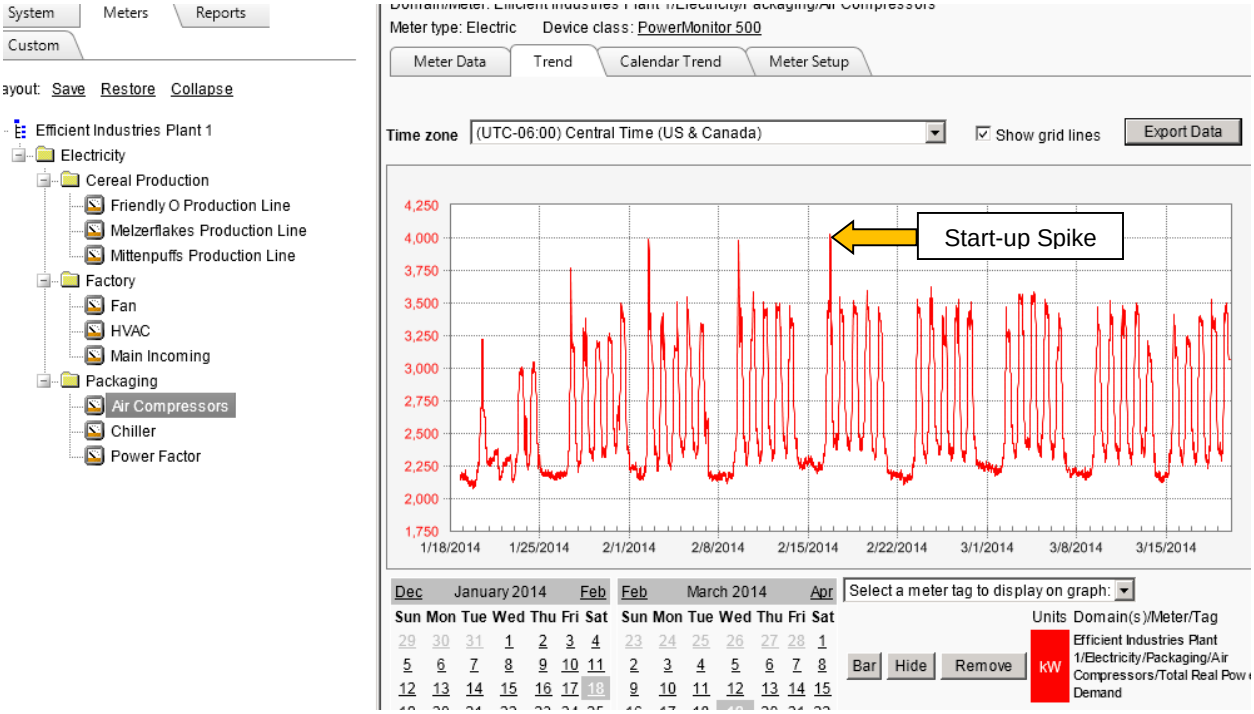
1. Click on "Meters" tab on the left navigation pane of the FTEM.

2. Click on a "Domain" level and corresponding "Meter" group in the left navigation tree. In this example, we selected "Efficient Industries Plant 1" domain level and the "Packaging" group. Change the date range from **Jan 18, 2014** to **March 19, 2014**.



3. Click on “Air Compressors” meter from the group selected above in the left navigation tree and then click on the “Trend” tab in the right pane of FTEM.

4. Select “Real Power Demand” tag from the “Select a meter tag to display on graph” dropdown list to view the demand trend.




5. In order to view the aggregate real power demand information of all the power monitors in a group, click the “Meter” group name and select “Real Power Demand” tag from the “Select a meter tag to display on graph” dropdown list. If the steps 3 & 4 are repeated for all the power monitors, the aggregate and individual real power demand information can be viewed on the same graph. **Note:** The aggregate real power demand graph can be viewed online only when all the individual power monitors in the selected “Meters” group have real power demand information.

From the above trend, you can notice the start-up spikes during first shift on Mondays in the first billing cycle. “Efficient Industries” deployed Rockwell Automation’s controllers to stagger their equipment startups and thus reduced their demand charges during the second billing cycle.

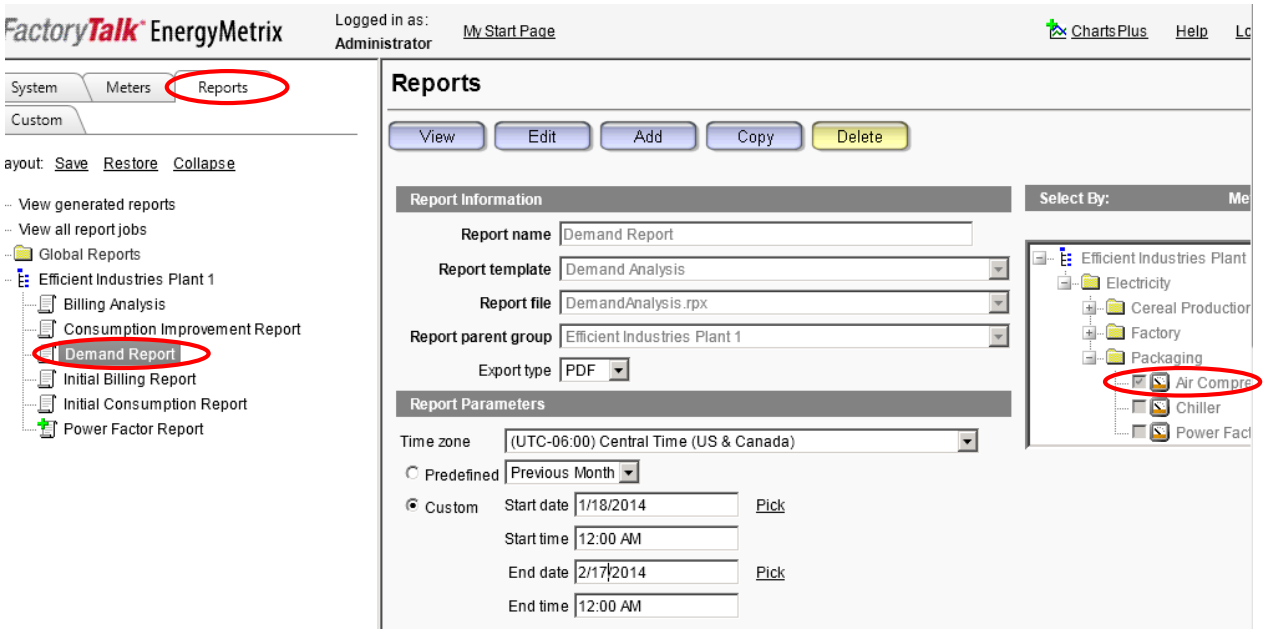
### Generating Electricity Demand Reports

In this section, we will guide you through a series of steps to generate electricity demand reports in FTEM software.

**Step by Step Instructions**

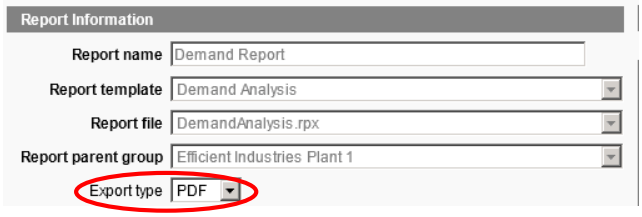
1. Click on “Reports” tab on the left navigation pane.

2. Click on a group level in the left navigation tree, and click on a consumption report. In this example, we selected “Efficient Industries Plant 1” group level and “Demand Report” report. As highlighted in the below screenshot, this is a pre-configured demand report for all the “Air Compressors” line.




3. You now have the capability to “View”, “Edit”, and “Delete” the selected report. You also have the capability to add a new report or build a new one on top of the existing report.

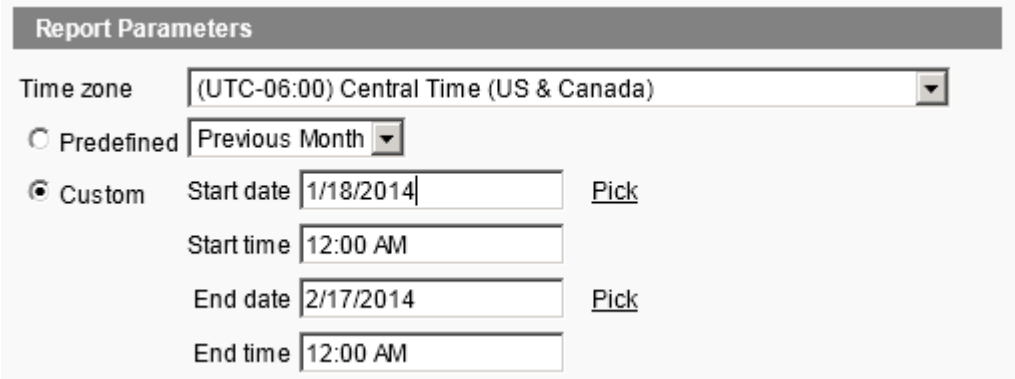
4. You can view the demand report in various file formats (pdf, excel, html, rtf, tiff). This can be achieved by selecting the appropriate “Export type” from the “Report Information” section.




5. You have options to view the electricity demand report during specific time durations by selecting appropriate “Predefined” or “Custom” options under the “Report Parameters” section.

a. By selecting the “Predefined” option, you have an option to quickly select the time duration based on standard sets such as “Previous Month”, “Previous Year”, “Year to Date” etc.

b. By selecting the “Custom” option, you now have the capability to specify exact date and time duration during which you want to view the demand report. In this scenario, enter **Jan 18, 2014 12:00 am** and **February 17, 2014 12:00 am** as start and end dates to view the demand report for the first billing cycle.




6. Upon making these selections, you can click on “View” button, to view the demand report of the selected meters.

7. You will notice an initial report generation message and then be able to view the report in the selected format.

FactoryTalk EnergyMetrix

**Efficient Industries Plant 1**
**Efficient Industries Plant 1**

***Demand Report***

1/18/2014 12:00 AM to 2/17/2014 12:00 AM

**Time Zone:** (UTC-06:00) Central Time (US & Canada)

**kW**

**Peak Demand Summary**

| | | | | |
|---|---|---|---|---|
| Air Compressors | | 4,025.1 kW | 100.0% | 2/16/2014 5:00:00 PM |
| | **Total** | **4,025.1 kW** | **100.0%** | |

**Worst Case Peak Demand Analysis**

| | | | | |
|---|---|---|---|---|
| Air Compressors | | 4,025.1 kW | 100.0% | 2/16/2014 5:00:00 PM |
| | **Total** | **4,025.1 kW** | **100.0%** | |

Please note from the below screenshot that the electricity demand during the first billing cycle is **4,025.1 kW**.

8. Change the start and end date as **February 18th, 2014 12:00 am** and **March 19th, 2014 12:00 am** to view the demand report for the second billing cycle.

Please note from the below screenshot that the electricity demand during second billing cycle is **3,623 kW**.

FactoryTalk EnergyMetrix

**Efficient Industries Plant 1**
**Efficient Industries Plant 1**

***Demand Report*** 2/18/2014 12:00 AM to 3/19/2014 12:00 AM

**Time Zone:** (UTC-06:00) Central Time (US & Canada)

**kW**

**Peak Demand Summary**

| | | | | |
|---|---|---|---|---|
| Air Compressors | 3,623.0 | kW | 100.0% | 2/24/2014 2:00:00 PM |
| **Total** | **3,623.0** | **kW** | **100.0%** | |

**Worst Case Peak Demand Analysis**

| | | | | |
|---|---|---|---|---|
| Air Compressors | 3,623.0 | kW | 100.0% | 2/24/2014 2:00:00 PM |
| **Total** | **3,623.0** | **kW** | **100.0%** | |

Based on the data listed in the report, you would be able to analyze the electrical demand during different time periods. From the above scenario, "Efficient Industries Plant 1" was able to save about **402.1 kW** (difference of electricity demand during both billing cycles).

## Generating Power Factor Reports

Utilities charge industrial customers for low power factors (typically for power factor less than 0.85). Electrical equipment that generates inductive loads, such as motors, creates current that is not in phase with the current supplied by the electric utility. Inductive loads cause the current waveform to lag behind the voltage waveform. This causes a portion of the energy to return to the source, hence leaving less usable power for the equipment.

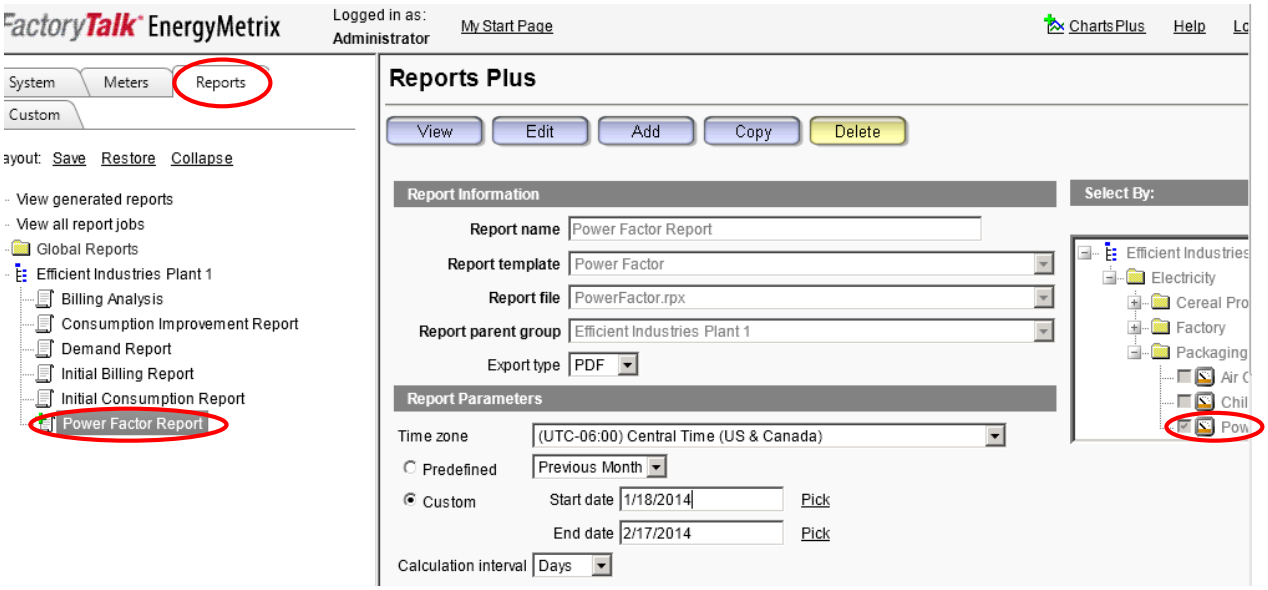
With a PowerMonitor 500, "Efficient Industries" noticed that their power factor was around 0.73 during the first billing cycle. The plant management has decided to improve the power factor by the use of capacitor banks. In this below scenario, Efficient Industries "Power Factor" line constitutes of a majority of the equipment contributing to the low power factor.

The list of steps to generate the power factor report are described below.

**Step by Step Instructions**

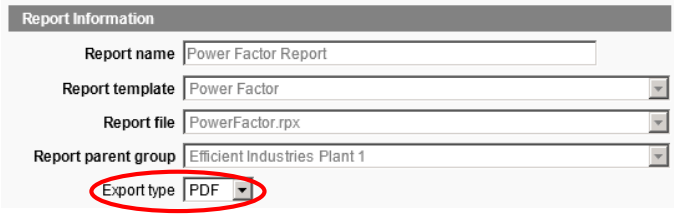
1. Click on “Reports” tab on the left navigation pane.

2. Click on a group level in the left navigation tree, and click on a power factor report. In this example, we selected “Efficient Industries Plant 1” group level and “Power Factor” report. As highlighted in the below screenshot, this is a pre-configured power factor report for the “Power Factor” line.




3. You now have the capability to “View”, “Edit”, and “Delete” the selected report. You also have the capability to add a new report or build a new one on top of the existing report.

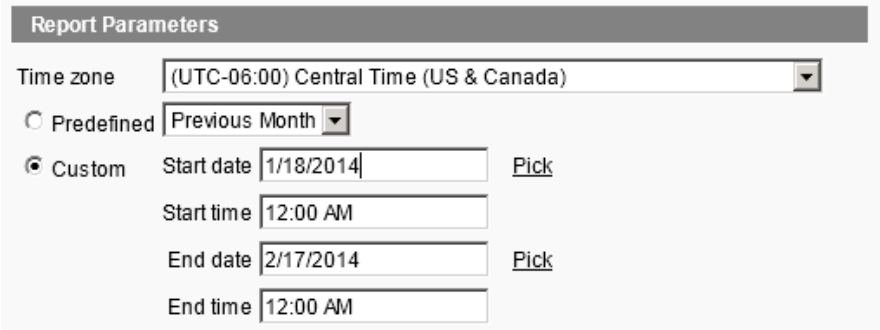
4. You can view the demand report in various file formats (pdf, excel, html, rtf, tiff). This can be achieved by selecting the appropriate “Export type” from the “Report Information” section.




5. You have options to view the power factor report during specific time durations by selecting appropriate “Predefined” or “Custom” options under the “Report Parameters” section.

   a. By selecting the “Predefined” option, you have an option to quickly select the time duration based on standard sets such as “Previous Month”, “Previous Year”, “Year to Date” etc.

   b. By selecting the “Custom” option, you now have the capability to specify exact date and time duration during which you want to view the power factor report. In this scenario, enter **Jan 18, 2014 12:00 am** and **February 17, 2014 12:00 am** as start and end dates to view the power factor report for the first billing cycle.




6. Upon making these selections, you can click on "View" button, to view the power factor report of the selected meters.

7. You will notice an initial report generation message and then be able to view the report in the selected format. Please note from the below screenshot that the power factor during the first billing cycle is **0.73**.

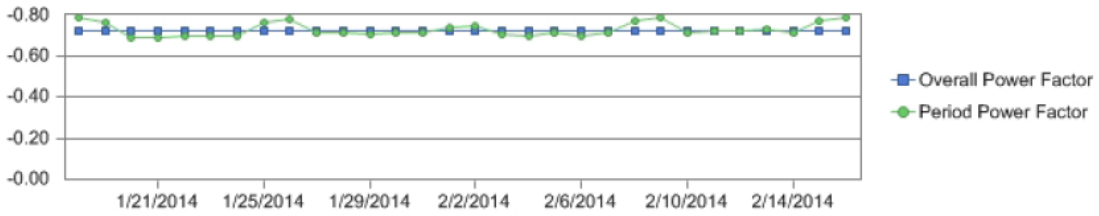
FactoryTalk EnergyMetrix

**Efficient Industries Plant 1**
**Efficient Industries Plant 1**

***Power Factor Report*** 1/18/2014 to 2/17/2014

**Time Zone:** (UTC-06:00) Central Time (US & Canada)

**Overall Power Factor:** -0.73




| Day | Real Energy | Reactive Energy | Power Factor |
|---|---|---|---|
| 1/18/2014 | 1,005.0 | 766.7 | -0.80 |
| 1/19/2014 | 4,017.3 | 3,333.6 | -0.77 |
| 1/20/2014 | 4,665.9 | 4,848.0 | -0.69 |

8. Change the start and end date as **February 18th, 2014 12:00 am** and **March 19th, 2014 12:00 am** to view the power factor report for the second billing cycle.

Please note from the below screenshot that the power factor during second billing cycle is **0.88**.

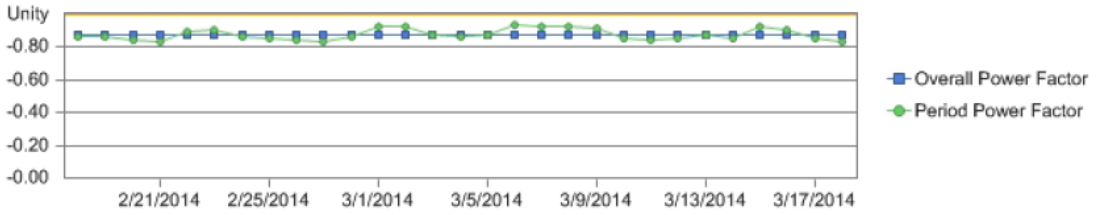
FactoryTalk EnergyMetrix

Efficient Industries Plant 1
Efficient Industries Plant 1

**Power Factor Report** 2/18/2014 to 3/19/2014

**Time Zone:** (UTC-06:00) Central Time (US & Canada)

**Overall Power Factor:** -0.88




| Day | Real Energy | Reactive Energy | Power Factor |
|---|---|---|---|
| 2/18/2014 | 6,496.1 | 3,676.6 | -0.87 |
| 2/19/2014 | 6,225.4 | 3,513.3 | -0.87 |
| 2/20/2014 | 5,572.7 | 3,586.7 | -0.84 |

Based on the data listed in the report, you would be able to average power factors during different time periods. From the above scenario, "Efficient Industries Plant 1" was able to improve the power factor to **0.88** by using capacitor banks.

## Generating Billing Reports

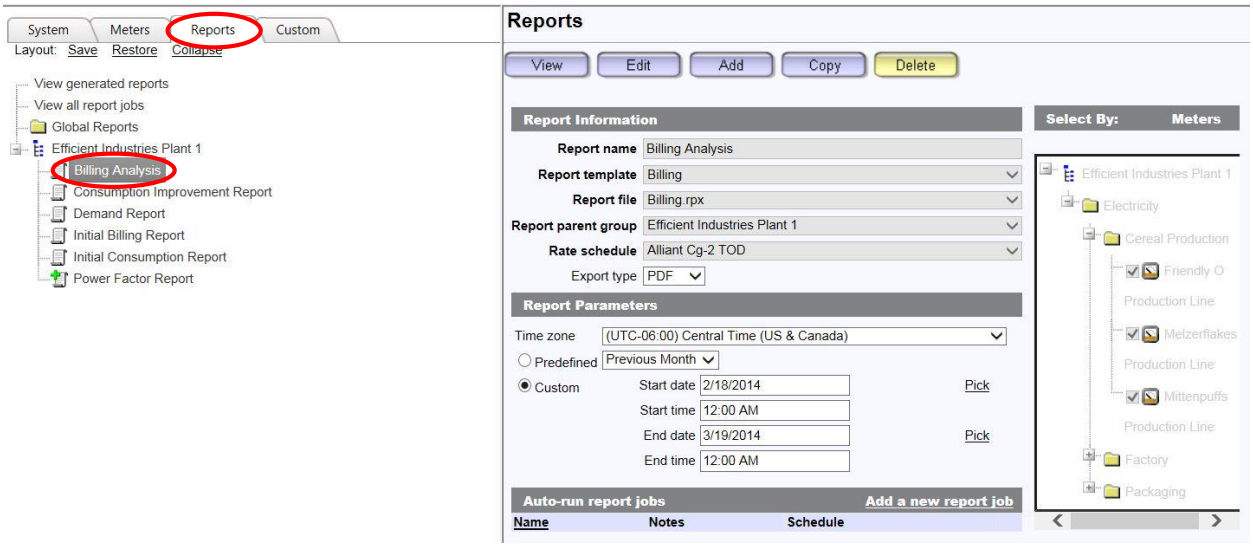
Using this feature, you have the ability to view the utility billing reports based on the electricity measurements such as electricity consumption (kWh), electricity demand (kW) and power factor from the power monitors combined with the respective rate schedules of the manufacturing plant. This data is greatly beneficial to check the accuracy of utility billing, prioritizing energy efficiency projects based on energy costs, negotiating a better rate structure with utilities etc.

The list of steps to generate a billing report are described below.

**Step By Step Instructions**

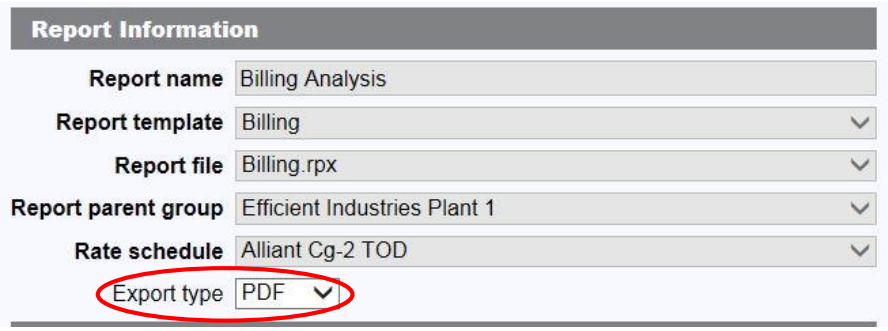
1. Click on "Reports" tab on the left navigation pane of the FTEM.

2. Click on a group level in the left navigation tree, and click on a billing report. In this example, we select "Efficient Industries Plant 1" group level and the "Billing Analysis" report.




3. You now have the capability to "View", "Edit", and "Delete" the selected report. You also have the capability to add a new report or build a new one on top of the existing report.

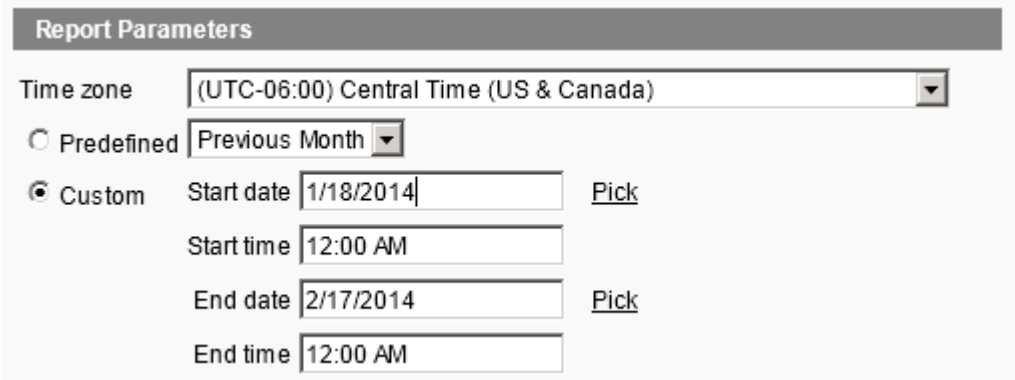
4. You can view the billing report in various file formats (pdf, excel, html, rtf, tiff). This can be achieved by selecting the appropriate "Export type" from the "Report Information" section. In this section, you also have the capability to run the billing reports based on different rate schedules. The rate schedule for "Efficient Industries" is "Alliant Cg-2 TOD".




5. You have options to view the billing report during specific time durations by selecting appropriate "Predefined" or "Custom" options under the "Report Parameters" section.

   c. By selecting the "Predefined" option, you have an option to quickly select the time duration based on standard sets such as "Previous Month", "Previous Year", "Year to Date" etc.

   d. By selecting the "Custom" option, you now have the capability to specify exact date and time duration during which you want to view the billing report. In this scenario, enter **Jan 18, 2014 12:00 am** and **February 17, 2014 12:00 am** as start and end dates to view the billing report for the first billing cycle.




6. Upon making these selections, you can click on "View" button, to view the billing report of the selected meters.

7. You will notice an initial report generation message and then be able to view the report in the selected format.

FactoryTalk EnergyMetrix

**Efficient Industries Plant 1**
**Efficient Industries Plant 1**

***Billing Analysis*** 1/18/2014 12:00 AM to 2/17/2014 12:00 AM

**Time Zone:** (UTC-06:00) Central Time (US & Canada)
**Rate Schedule:** Alliant Cg-2 TOD
**Total Charge:** $119,438.29

**Energy Charges**

| Description | Quantity | Rate | Charge |
|---|---|---|---|
| On Peak Energy Charge | 789,810.5 kWh | 0.05797 | $45,785.31 |
| Off Peak Energy Charge | 997,503.0 kWh | 0.03931 | $39,211.84 |
| | | **Subtotal:** | **$84,997.15** |

**Demand Charges**

| Description | Quantity | Rate | Charge |
|---|---|---|---|
| On-Peak Demand Charge | 3,588.5 kW | 7.65 | $27,451.87 |
| Customer Demand Charge | 3,588.5 kW | 1.94 | $6,961.65 |
| | | **Subtotal:** | **$34,413.52** |

**Customer Charges**

| Description | Quantity | Rate | Charge |
|---|---|---|---|
| Customer Charge | 30.0 Day(s) | 0.9205 | $27.62 |
| | | **Subtotal:** | **$27.62** |

Please note from the above screenshot that the electricity costs during the first billing cycle is **$119,438**.

"On peak" periods are defined as specified time intervals of high utility demand during which energy costs are higher. Note that while less energy was consumed during on peak hours, the user is spending more money for on peak energy use.

8. Change the start and end date as **February 18th, 2014 12:00 am** and **March 19th, 2014 12:00 am** to view the billing report for the second billing cycle.

Please note from the below screenshot that the total electricity costs during second billing cycle is **$88,394**.

FactoryTalk EnergyMetrix

**Efficient Industries Plant 1**
**Efficient Industries Plant 1**

***Billing Analysis*** 2/18/2014 12:00 AM to 3/19/2014 12:00 AM

**Time Zone:** (UTC-06:00) Central Time (US & Canada)
**Rate Schedule:** Alliant Cg-2 TOD
**Total Charge:** $88,394.66

**Energy Charges**

| Description | Quantity | Rate | Charge |
|---|---|---|---|
| On Peak Energy Charge | 602,657.4 kWh | 0.05797 | $34,936.05 |
| Off Peak Energy Charge | 688,600.6 kWh | 0.03931 | $27,068.89 |
| | | **Subtotal:** | **$62,004.94** |

**Demand Charges**

| Description | Quantity | Rate | Charge |
|---|---|---|---|
| On-Peak Demand Charge | 2,536.1 kW | 7.65 | $19,401.38 |
| Customer Demand Charge | 3,588.5 kW | 1.94 | $6,961.65 |
| | | **Subtotal:** | **$26,363.03** |

**Customer Charges**

| Description | Quantity | Rate | Charge |
|---|---|---|---|
| Customer Charge | 29.0 Day(s) | 0.9205 | $26.69 |
| | | **Subtotal:** | **$26.69** |

From the above scenario, “Efficient Industries Plant 1” was able to save about **$31,043** (difference of electricity costs during both billing cycles) through various energy efficiency initiatives. Thus, monitoring and analyzing data would be greatly beneficial to identify various energy efficiency opportunities and also to validate the cost savings achieved by implementing these opportunities.

## Part 3: Understanding Power Quality

Power quality events, generally referring to deviations from an ideal sinusoidal voltage waveform, can lead to significant cost in the form of plant downtime and equipment replacement cost. There are several types of electrical disturbances, but the ones with the greatest effects on industrial customers are voltage sags, transients, and harmonics.

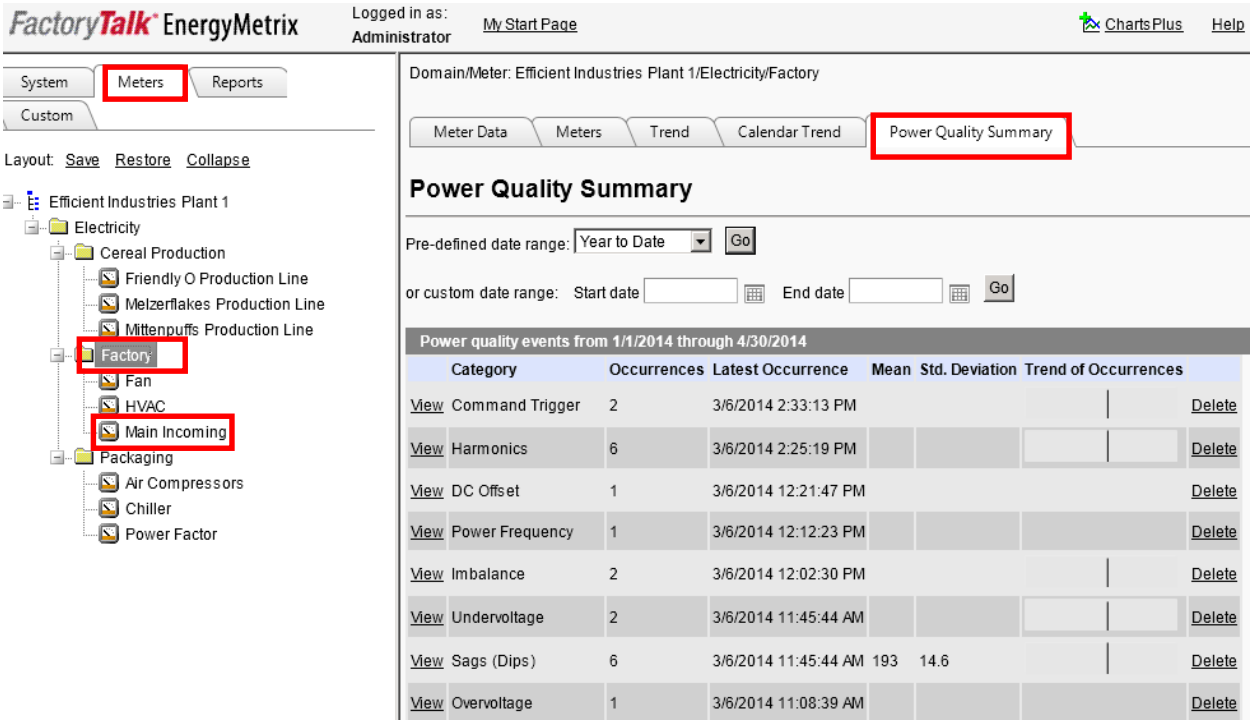
### Viewing Voltage Sags

Voltage sags are one of the most important power quality problems facing many industrial customers. They are a reduction in AC voltage that can last from 0.5 cycles to 1 minute. These are usually caused by system faults or heavy startup current due to switching on loads and can result in damaged equipment, data corruption, errors in industrial processing, and system halts.

**Step by Step Instructions**

1. Click on the "Meters" tab on the left navigation pane of the FTEM.

2. Click on the "Factory" group level in the left navigation tree and then the "Main Incoming" meter. Afterwards, click on the "Power Quality Summary" tab on the right pane.



3. On this summary page, you will be able to view the list of all power quality events associated with the selected PowerMonitor. Click on the "View" link beside the "Sags (Dips)" category to view a list of all voltage sag events.

Click this link

**Power quality events from 1/1/2014 through 4/30/2014**

| | Category | Occurrences | Latest Occurrence | Mean | Std. Deviation | Trend of Occurrences | |
|---|---|---|---|---|---|---|---|
| View | Undervoltage | 2 | 3/6/2014 11:45:44 AM | | | | Delete |
| View | Sags (Dips) | 6 | 3/6/2014 11:45:44 AM | 193 | 14.6 | | Delete |
| View | Overvoltage | 1 | 3/6/2014 11:08:39 AM | | | | Delete |

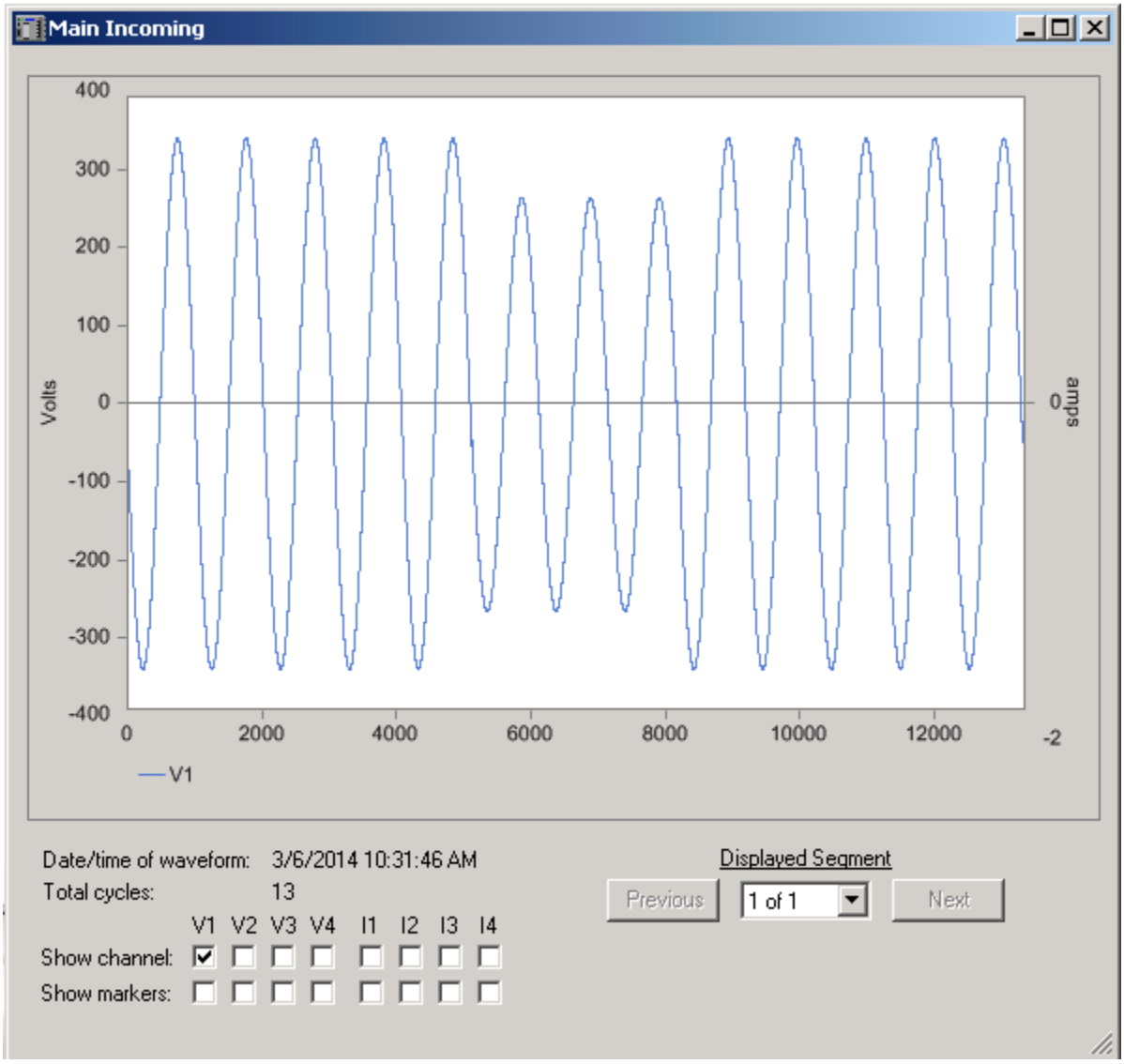
4. The "Power Quality Event Details" page lists detailed information pertaining to all the voltage sag events with the selected PowerMonitor.

## Power Quality Event Details

**Sags (Dips) power quality events from 1/1/2014 through 4/22/2014**

| Device Id | Device Name | Event | Date/Time | Trip Point | Magnitude | Duration | Waveform | |
|---|---|---|---|---|---|---|---|---|
| 2 | Main Incoming | V2_Sag | 3/6/2014 11:45:44 AM | 80% | 180.2 V | 60000 ms | View | Delete |
| 2 | Main Incoming | V2_Sag | 3/6/2014 11:45:44 AM | 90% | 180.2 V | 60000 ms | View | Delete |
| 2 | Main Incoming | V2_Sag | 3/6/2014 10:44:54 AM | 90% | 211.2 V | 60000 ms | View | Delete |
| 2 | Main Incoming | V1_Sag | 3/6/2014 10:31:46 AM | 80% | 187.4 V | 41.6 ms | View | Delete |
| 2 | Main Incoming | V1_Sag | 3/6/2014 10:31:46 AM | 90% | 187.4 V | 50 ms | View | Delete |
| 2 | Main Incoming | V1_Sag | 3/6/2014 10:28:04 AM | 90% | 211.4 V | 75 ms | View | Delete |

5. Click on the "View" link of the fourth voltage sag event to view the corresponding waveform. Below is the V1_Sag at 10:31:46AM that lasts 41.6 ms. On this waveform page, you also have options to choose different voltage and current channels.




The ability to identify various voltage sags allows industrial customers to deploy sag mitigation products such as Uninterruptible Power Supplies (UPS) and Dynamic Sag Correctors (DySC). This is often critical in safeguarding electronically controlled equipment (i.e. process controllers, programmable logic controllers, variable frequency drives) that are often sensitive to deviations in supply voltage, helping to avoid costs in the form of equipment replacement and plant downtime.

## Viewing Harmonic Data

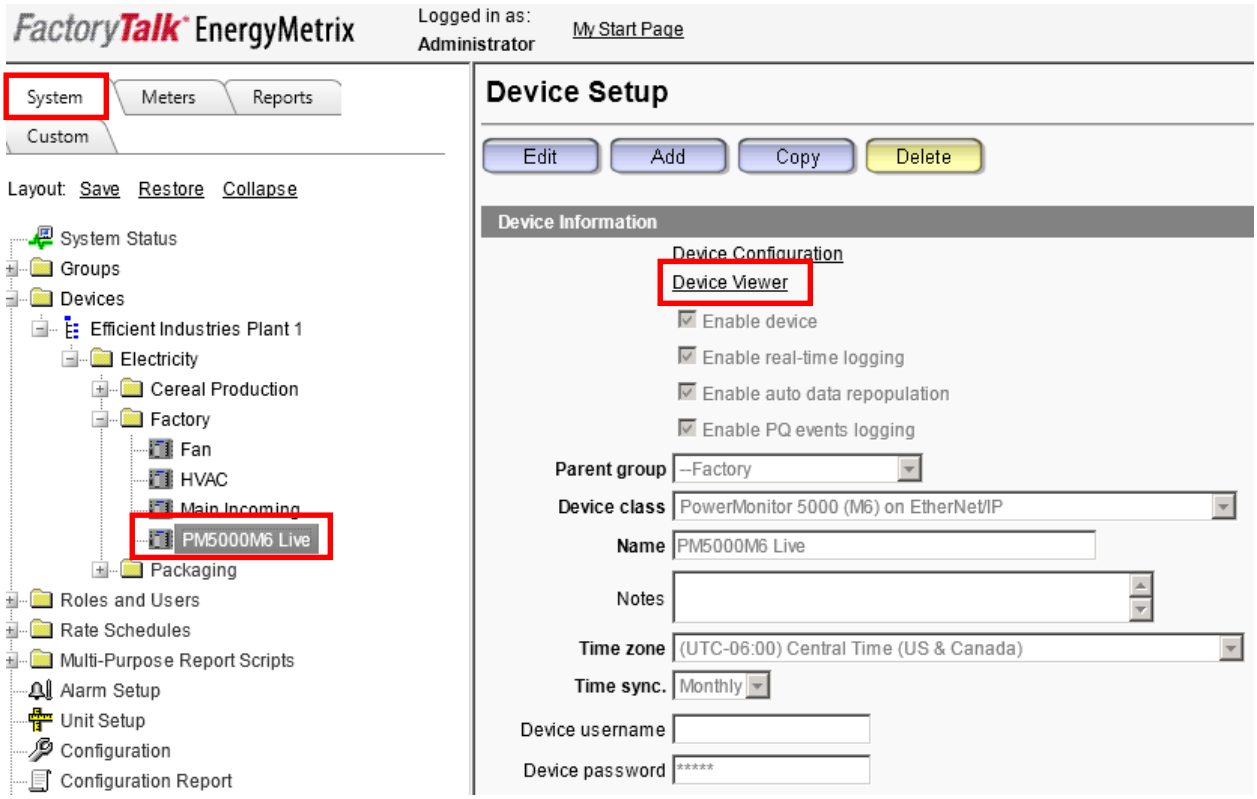
When nonlinear devices, such as a drive, is present in an electrical system, the sinusoidal voltage waveform is distorted into one comprised of frequencies that are multiples of the fundamental (60 Hz). Having harmonics present in your system can lead to overheated transformers and other electrical distribution equipment, drives shutting down, and circuit breakers tripping.

The PowerMonitor 5000 can be used in conjunction with FTEM to understand how much harmonic waveform distortion is present in the electrical system. This is expressed for individual harmonics, as well as cumulatively in the form of Total Harmonic Distortion (THD).

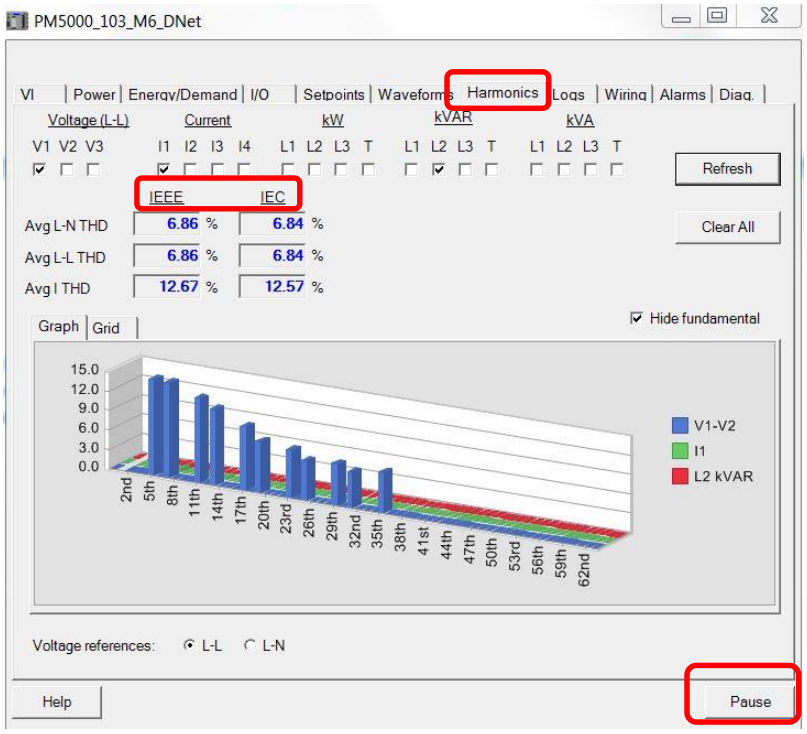
### Step by Step Instructions

1. Click on the “System” tab on the left navigation pane.

2. Click on the “Factory” group level in the left navigation tree, and click on the PowerMonitor named “PM5000M6 Live”.



3. Click the “Device Viewer” link on the “Device Setup” page to access the harmonics data. The magnitude of different orders of harmonics on the selected channels is displayed on the “Harmonics” tab. Total Harmonic Distortion (THD) is calculated according to both IEEE and IEC standards.




4. This page also has the capability to select “Pause” to capture a particular dataset at any point of time and to select the “Continue” button to continue to view the real time harmonics data.

> Upon detection of significant harmonic distortion, harmonics can be mitigated with passive and active filters offered by our Encompass Partners. Specific to drive harmonic mitigation, line reactors, isolation transformers, and common mode chokes can be utilized.

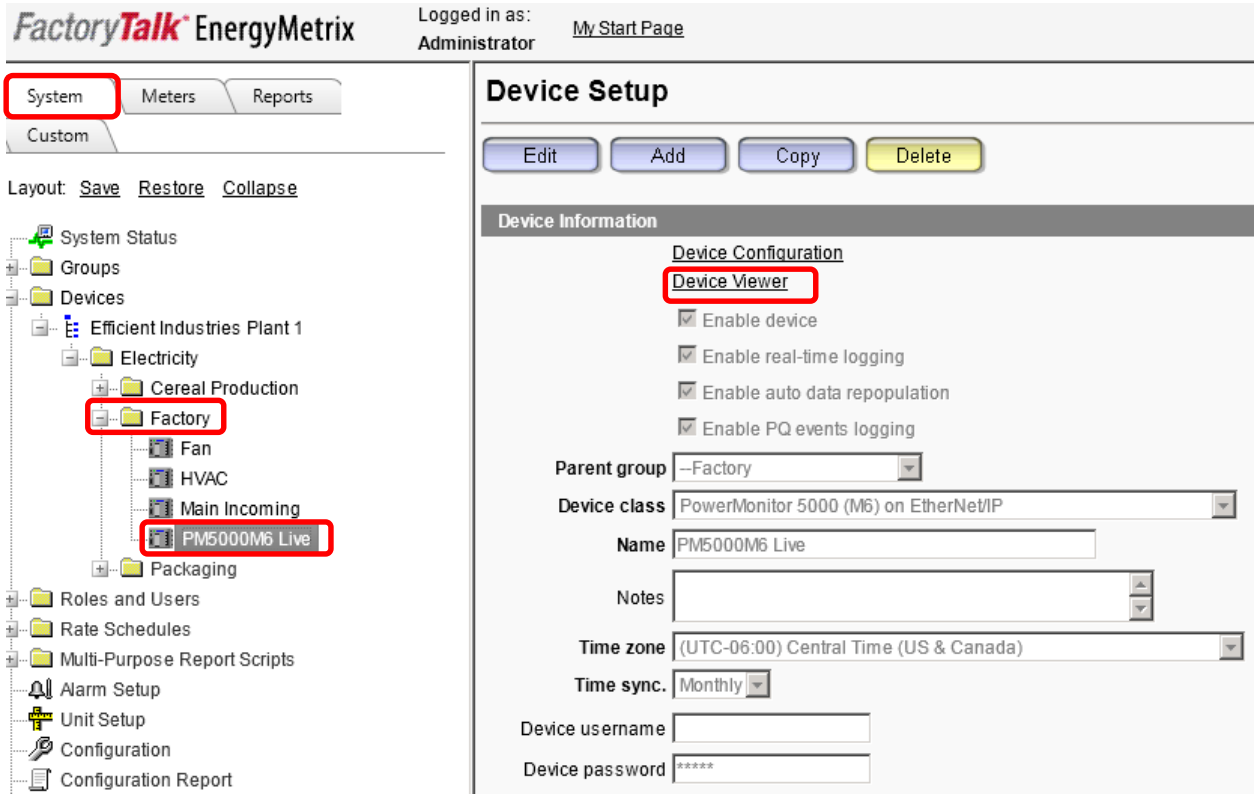
## Viewing Real Time (RT) Voltage and Current Data

> Using this feature, you have the ability to view the live voltage, current, frequency, and phase rotation data from the power monitors.

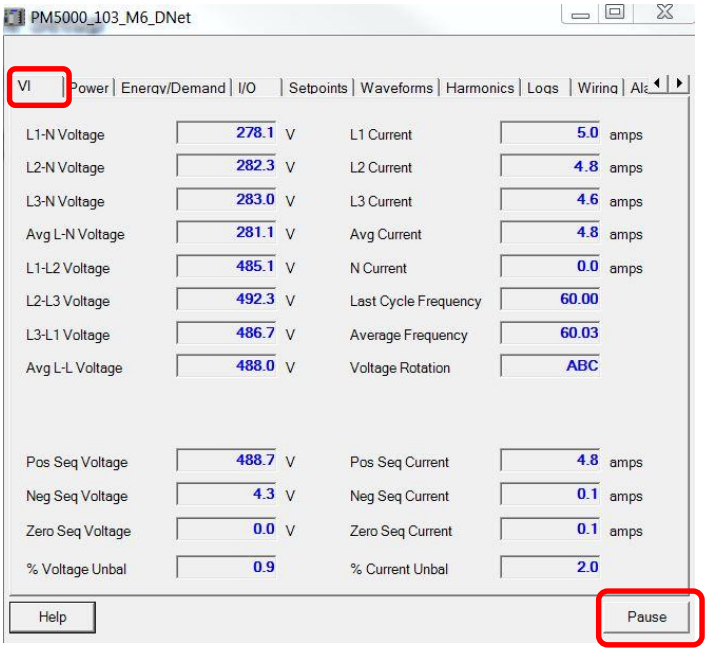
### Step by Step Instructions

1. Click on the “System” tab on the left navigation pane.

2. Click on the “Factory” group level in the left navigation tree and then the “PM5000 M6 Live” PowerMonitor.




3. Click the “Device Viewer” link on the “Device Setup” page to access the real time data page. The information is displayed on the “VI” tab. This page also has the capability to select the “Pause” button to capture a particular dataset at any point of time and to select the “Continue” button to continue to view the real time data after the information has been captured.



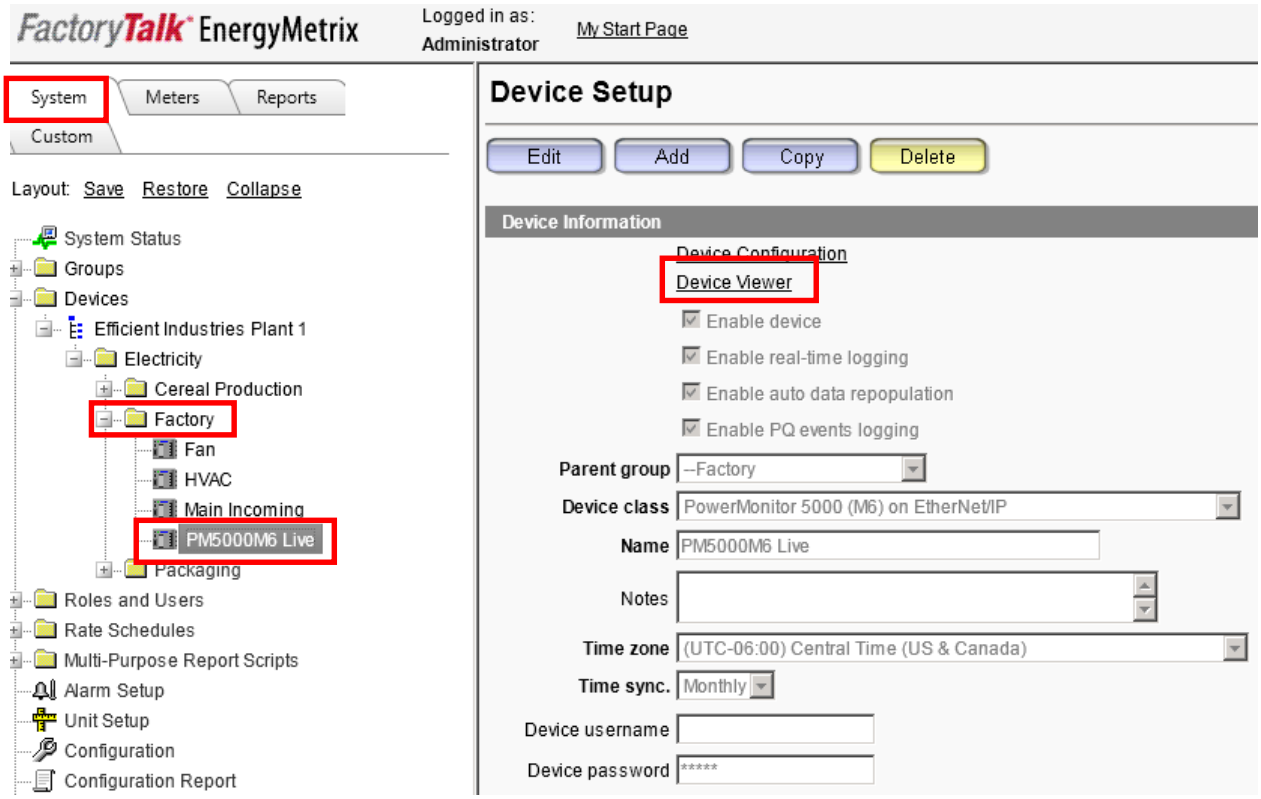
## Viewing Alarms

Using this feature, you have the ability to view active and all alarms associated with the Power Monitors.

### Step by Step Instructions

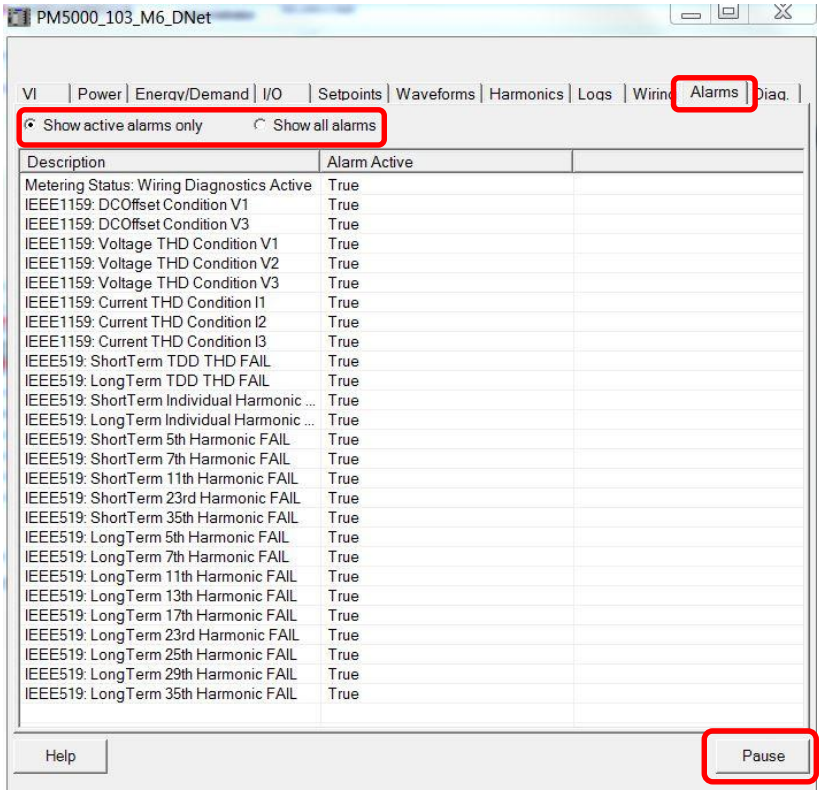
1. Click on the “System” tab on the left navigation pane of the FTEM.

2. Click on the “Factory” group level in the left navigation tree, and then click on the “PM5000M6 Live” PowerMonitor.

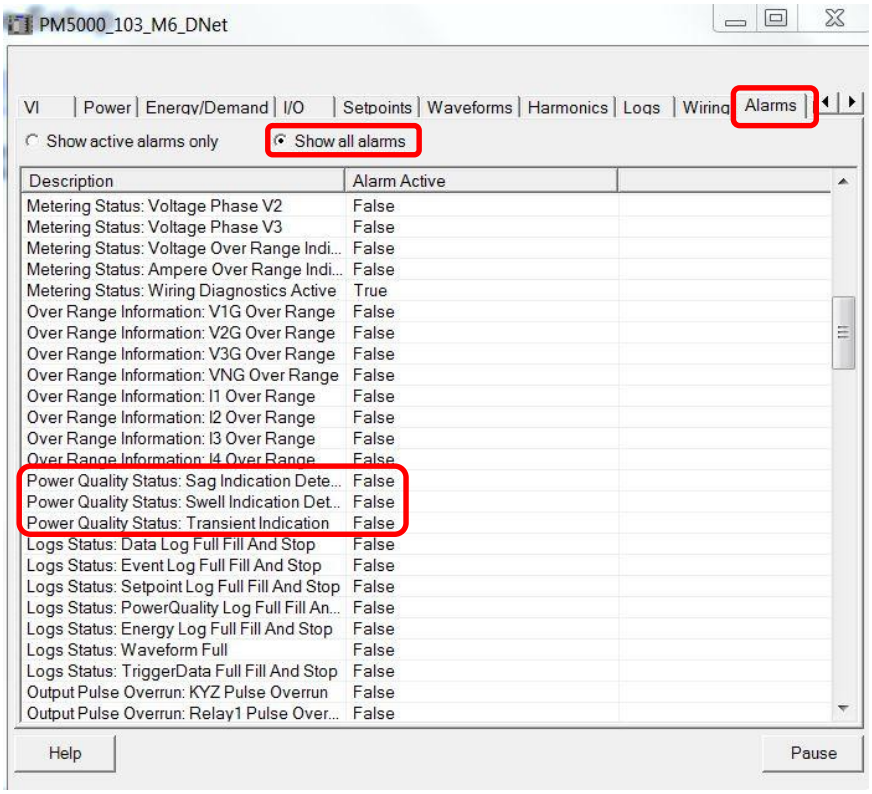



3. Click the “Device Viewer” link on the “Device Setup” page to access the alarms information on “Alarms” tab. On this page, you have the options to view “Show active alarms only” and “Show all alarms”.

4. This page also has the capability to select the “Pause” button to capture the alarm status at any point of time and to select the “Continue” button to continue to view the real time alarm status.


PM5000_103_M6_DNet
VI | Power | Energy/Demand | I/O | Setpoints | Waveforms | Harmonics | Logs | Wiring | Alarms | Diag.
Show active alarms only
Show all alarms
Description
Alarm Active
Metering Status: Wiring Diagnostics Active True
IEEE1159: DCOffset Condition V1 True
IEEE1159: DCOffset Condition V3 True
IEEE1159: Voltage THD Condition V1 True
IEEE1159: Voltage THD Condition V2 True
IEEE1159: Voltage THD Condition V3 True
IEEE1159: Current THD Condition I1 True
IEEE1159: Current THD Condition I2 True
IEEE1159: Current THD Condition I3 True
IEEE519: ShortTerm TDD THD FAIL True
IEEE519: LongTerm TDD THD FAIL True
IEEE519: ShortTerm Individual Harmonic ... True
IEEE519: LongTerm Individual Harmonic ... True
IEEE519: ShortTerm 5th Harmonic FAIL True
IEEE519: ShortTerm 7th Harmonic FAIL True
IEEE519: ShortTerm 11th Harmonic FAIL True
IEEE519: ShortTerm 23rd Harmonic FAIL True
IEEE519: ShortTerm 35th Harmonic FAIL True
IEEE519: LongTerm 5th Harmonic FAIL True
IEEE519: LongTerm 7th Harmonic FAIL True
IEEE519: LongTerm 11th Harmonic FAIL True
IEEE519: LongTerm 13th Harmonic FAIL True
IEEE519: LongTerm 17th Harmonic FAIL True
IEEE519: LongTerm 23rd Harmonic FAIL True
IEEE519: LongTerm 25th Harmonic FAIL True
IEEE519: LongTerm 29th Harmonic FAIL True
IEEE519: LongTerm 35th Harmonic FAIL True
Help
Pause

5. Click on “Show all alarms” to view ALL the alarms associated with the selected power monitor. You can scroll through the entire list and view the alarms associated with Power Quality, as depicted in the below picture.


PM5000_103_M6_DNet
VI | Power | Energy/Demand | I/O | Setpoints | Waveforms | Harmonics | Logs | Wiring | Alarms
Show active alarms only
Show all alarms
Description
Alarm Active
Metering Status: Voltage Phase V2 False
Metering Status: Voltage Phase V3 False
Metering Status: Voltage Over Range Indi... False
Metering Status: Ampere Over Range Indi... False
Metering Status: Wiring Diagnostics Active True
Over Range Information: V1G Over Range False
Over Range Information: V2G Over Range False
Over Range Information: V3G Over Range False
Over Range Information: VNG Over Range False
Over Range Information: I1 Over Range False
Over Range Information: I2 Over Range False
Over Range Information: I3 Over Range False
Over Range Information: I4 Over Range False
Power Quality Status: Sag Indication Dete... False
Power Quality Status: Swell Indication Det... False
Power Quality Status: Transient Indication False
Logs Status: Data Log Full Fill And Stop False
Logs Status: Event Log Full Fill And Stop False
Logs Status: Setpoint Log Full Fill And Stop False
Logs Status: PowerQuality Log Full Fill An... False
Logs Status: Energy Log Full Fill And Stop False
Logs Status: Waveform Full False
Logs Status: TriggerData Full Fill And Stop False
Output Pulse Overrun: KYZ Pulse Overrun False
Output Pulse Overrun: Relay1 Pulse Over... False
Help
Pause

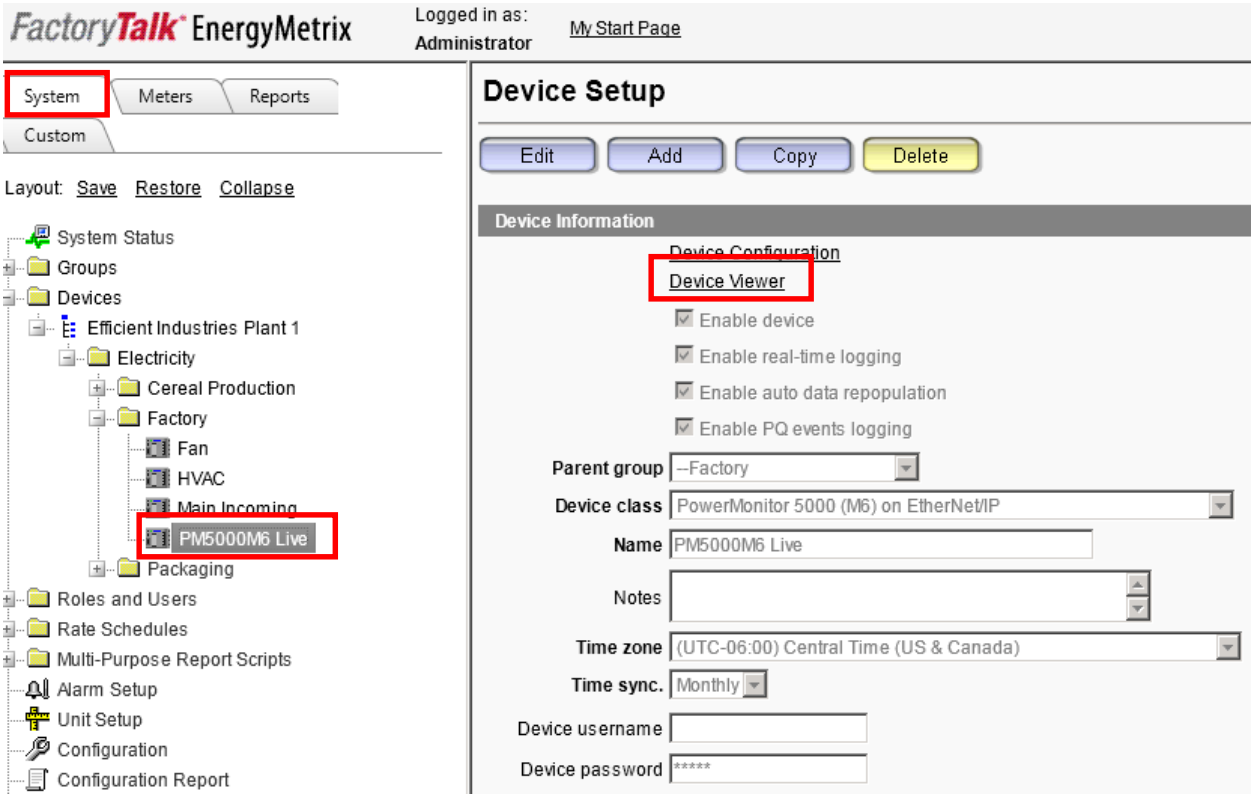
## Viewing Wiring Information

Using this feature, you have the ability to perform wiring diagnostics, analyze the wiring correction status, and execute the wiring connection commands.

### Step by Step Instructions

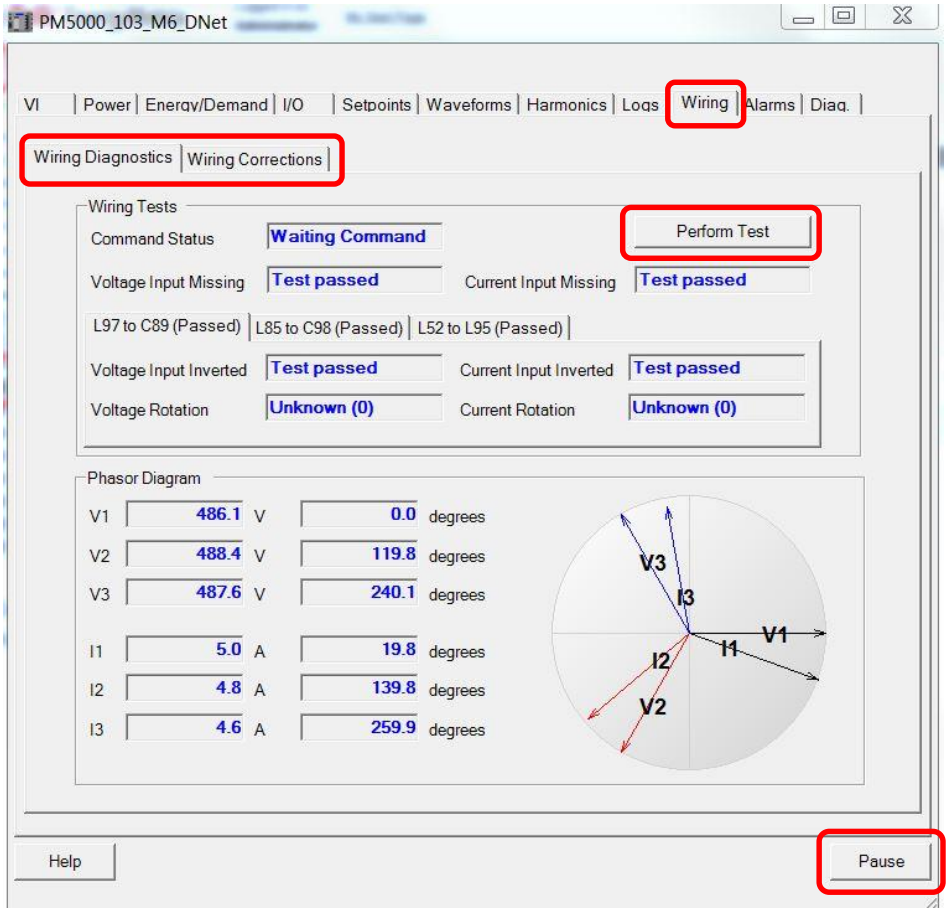
1. Click on the “System” tab on the left navigation pane.

2. Click on the “Factory” group level in the left navigation tree, and then click on the “PM5000M6 Live” Power Monitor.




3. Click the “Device Viewer” link on the “Device Setup” page to access the wiring information on the “Wiring” tab. On this page, you have options to access “Wiring Diagnostics” & “Wiring Corrections” information.

4. This page also has the capability to select the “Pause” button to capture a particular dataset at any point of time and to select the “Continue” button to continue to view the real time voltage phasor information.




The Real Time Device Viewer gives the user additional functionality to monitor real time power data.

# Appendix

## A. Power 101

The PowerMonitor 5000 uses basic electrical principles to function and operate. This appendix briefly describes electrical and power terms that are pertinent to the PowerMonitor 5000 functionality.

Ampere (Amp) (I) - Unit of measure for current flowing in a circuit

Volt (V) - Unit of measure for a potential or "pressure" that pushes current through a circuit

Ohm (Z) - Unit of measure for impedance, which resists or "impedes" the flow of current

- Resistance (R)
- Inductive Reactance ($X_L$)
- Capacitive Reactance ($X_C$)

Direct Current (DC) – Volts and Amps always "push" and "flow" in the same direction

Alternating Current (AC) – Current changes direction many times per second

Hertz (Hz) – Unit of measure for Frequency (changes of direction per second). 60 Hz in USA, 50 Hz in EU

Single Phase vs. Three Phase - Single-phase generators have a single winding. Three phase generators have three windings

Real Power (P) – The rate of energy transfer. Produces heat, mechanical work, and chemical work. Voltage and current are in phase.

Reactive Power (Q) – Voltage and current are not in phase. Reactive power is stored in magnetic and electric fields.

Apparent Power (S) – Dictates the capacity requirements of the system

Power Factor - Ratio of Real to Apparent Power

- Power factor can be Leading or Lagging
  - Lagging means the load is more inductive
  - Leading means the load is more capacitive
- Leading Power Factor can be undesirable - Can cause voltage control problems
- Utilities may impose a Power Factor Penalty

Energy – Power * Time Interval

- Units of measure:
  - Watt-hours (Wh)
  - kWh, MWh

Demand - Average rate of energy transfer during each **Demand Interval**

- Demand Interval set by the energy provider
- Demand Interval is usually fixed interval but may be a "sliding window"
- Demand Interval is typically 15 minutes long but may be 30 or 60 minutes
- Single highest interval Demand occurring in the billing period is the **Peak Demand**
- Units of measure same as Power (kW)
- Demand dictates the minimum capacity of the electrical system

Power Quality - The absence of malfunctions or failures caused by power anomalies

- Sags: voltage dips > 10%
- Swells: voltage rises > 10%
- Interruptions
- Noise, harmonics, unbalance

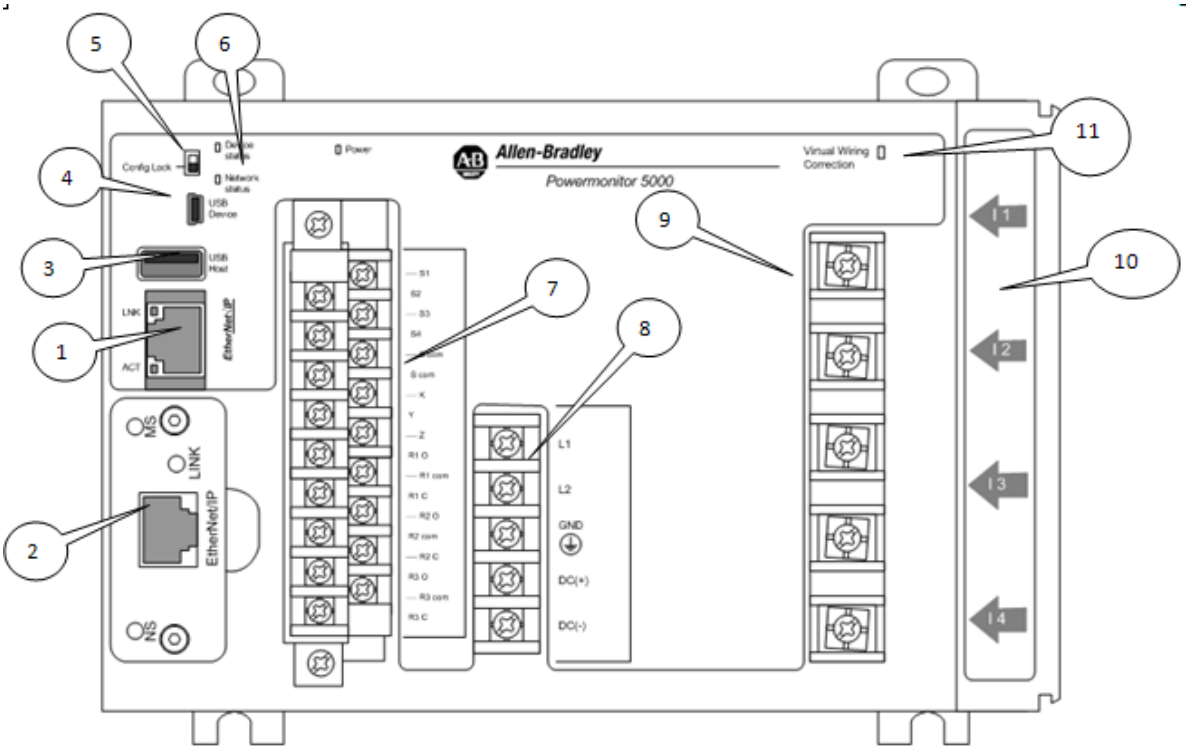
**PowerMonitor 5000 features and functions**

The PowerMonitor 5000 is the next generation of high-end electric metering products from Rockwell Automation. This new family of meters provides advanced technology, new functionality, faster response and superior accuracy. The M5 model is the base version and provides an extensive range of metering functionality. The **PowerMonitor 5000** communicates power and energy parameters to **controllers, HMI software, and applications such as FactoryTalk EnergyMetrix** over Ethernet or other optional networks. The PowerMonitor 5000 works with controllers or software applications to address key customer applications including:

- Load profiling – logging power parameters such as real power, apparent power and demand, for analysis of power usage by loads over time
- Cost allocation – reporting actual energy cost by department or process to integrate energy information into management decisions
- Billing and sub-billing – charging users of energy the actual usage cost rather than allocating by square footage or other arbitrary methods
- Power system monitoring and control – display and control power flow and energy utilization
- Demand management – monitoring power usage and controlling loads to reduce demand costs
- Demand response – controlling and monitoring usage in response to an energy provider's instruction to reduce demand

The PowerMonitor 5000 connects to the user's three-phase or single-phase AC power system directly or through instrument transformers (PTs and CTs). It converts instantaneous voltage and current values to digital values, and uses the resulting digital values in calculations of voltage, current, power, energy, etc.

**Hardware features**




1. Ethernet port – standard RJ-45 jack with LED indicators
   Ethernet port hardware is included on all models. These protocols and functions are supported:
   - Ethernet/IP
   - HTML web page for configuration and data access

   Ethernet indicators

- LNK Indicator
  - Solid GREEN: IP link established
  - Off: No link established
- ACT Indicator
  - Flashing YELLOW: Data present on Ethernet port
  - Off: No data activity present

2. Optional communications port (future)

3. USB host port
   USB standard A receptacle. Not used in this model.

4. USB device port
   The USB device port is a USB Mini-B receptacle that accepts standard USB Mini-B plugs, for connection to a host device such as a notebook computer.

5. Configuration Lock switch
   When enabled, this switch prevents changes in configuration that would affect revenue accuracy.

6. Power, Device and Network status indicators
   - Power status
     - OFF: No control power
     - GREEN: Control power is present
   - Device status
     - OFF: No control power
     - Flashing GREEN/RED: Power monitor is booting up
     - Flashing GREEN: Power monitor has not been configured
     - GREEN: Power monitor is running
     - Flashing RED: Power monitor has detected a recoverable minor fault
     - RED: Power monitor has detected a non-recoverable major fault
   - Network status
     - OFF: No control power
     - Flashing GREEN/RED: Power monitor is booting up
     - Flashing GREEN: [seems to blink green no matter what]
7. Status input, KYZ output and control relay wiring terminals
   - Four internally-powered status inputs
   - S2 may be used for demand period synchronization
   - KYZ DPDT solid-state relay for signaling use
   - Three DPDT control relays
8. Control power and ground wiring terminals
   - 120…240 VAC, 50-60 Hz
   - 24 VDC

9. Voltage sensing wiring terminals
   - Direct connect to up to 690 VAC 3-phase line to line
   - Maximum nominal line to ground voltage 398
   - Use potential transformers (PTs) for higher voltages
   - Neutral voltage and ground voltage connections

10. Current sensing wiring openings
    - Nominal input current 5 amps
    - Use current transformers (CTs) to connect to power system

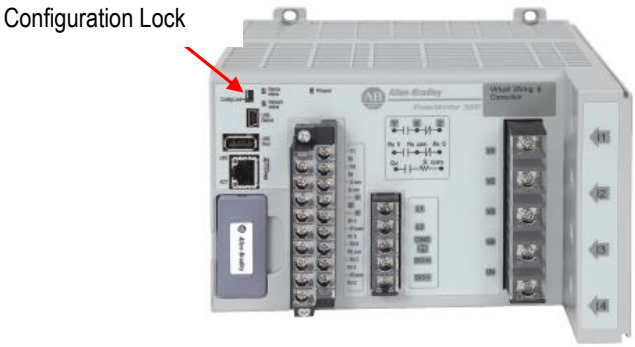
11. Virtual wiring correction indicator
    Indicates that the sensing voltage and/or current wiring has been modified in the power monitor configuration.

### Connecting via USB

The USB Device port can be used to set-up a temporary, point-to-point connection between a personal computer and the PowerMonitor™ 5000 unit. This connection is used for configuration, data monitoring, diagnostics, and maintenance by using the unit's built-in web pages. The USB Device port is a standard USB Mini-B receptacle. You need to install drivers to enable USB communication. You may download the USB drivers from the http://www.rockwellautomation.com/compatibility web page.

### Configuration Lock

The configuration lock is a switch located on the PowerMonitor 5000. When the configuration lock is switched into the lock position it prevents unauthorized changes to the PowerMonitor 5000 unit setup. The configuration lock is shown in the PowerMonitor 5000 image below.




### Wiring Voltages and Current

Voltage sensing

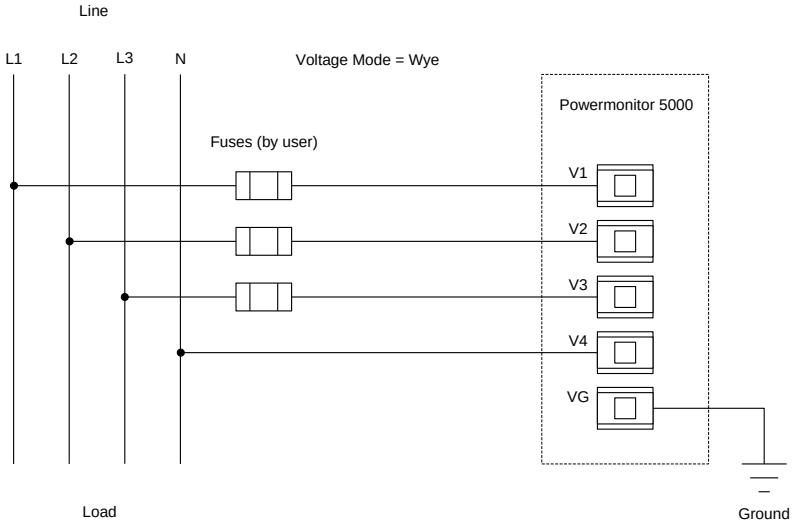
The PowerMonitor 5000 is capable of monitoring a variety of three-phase and single-phase circuits. Circuits rated up to 690 VAC line-to-line may be connected directly. Higher voltages require potential transformers (PTs), also known as voltage transformers (VTs), to step the voltage down. Wiring must conform to all applicable codes and standards. In particular, suitable overcurrent protection must be provided by the user, with current and interrupting ratings selected to protect the wiring. Pay particular attention to correct phasing and polarity of voltage connections. The diagrams use the “dot” convention to indicate transformer polarity. The dot indicates the H1 and X1 terminals on the high side and low side of the transformer respectively.

It is essential to have correct wiring for the power monitor to calculate correct power, demand and energy usage. Power is a vector product, in a typical 3 phase balanced system, phase voltage/current to next phase voltage/current is 120 degrees apart and it’s critical that current signals line up with voltage signals with correct polarity. It is a common issue in the field to have incorrect wiring. A simple method to identify a typical consumption inductive electric load (such as motors/transformer load, MCC, building automation, arch furnace, lighting…etc.) with correct wiring will show positive kW, positive kVAR, and lagging power factor. When it’s determined that there is incorrect wiring, the correction is not a convenient task as it often requires waiting until the next planned shutdown to make the correction. The PowerMonitor 5000 wiring diagnostics and virtual wiring connections are helpful in achieving correct metering results without changing the physical wiring connections.

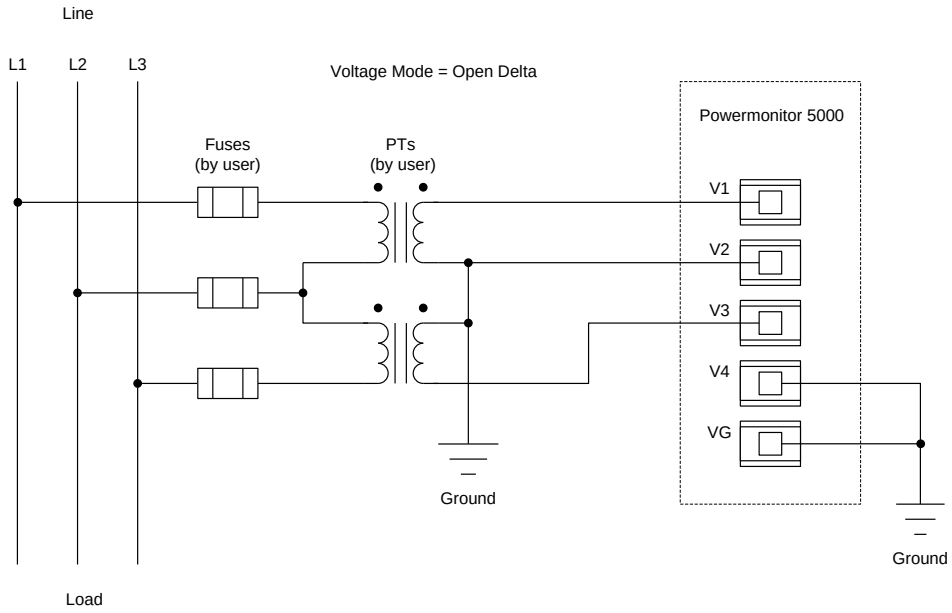
When wiring a PowerMonitor 5000 to existing PTs and metering devices, the voltage sensing terminals of the PowerMonitor 5000 must be connected in parallel with the voltage sensing terminals of the existing metering devices.

The following wiring diagrams indicate typical voltage sensing connections to various types of power systems. Here is just an example of Direct connect for WYE system.

**Three Phase, 4-wire Wye, Direct Connect (690 VAC Line to Line Maximum)**

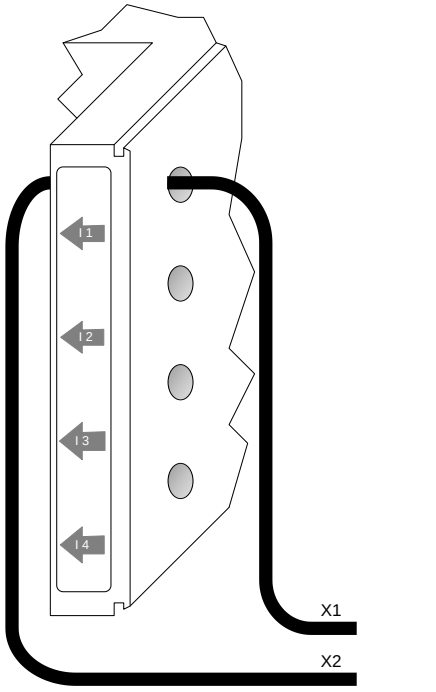



**Three Phase. 3-wire Open Delta with Two PTs**




## Current Sensing

Route the CT secondary wiring through the openings in the PowerMonitor 5000 as shown.




Use a shorting terminal block, test block or shorting switch (by user) for CT wiring to permit safely servicing connected equipment such as the PowerMonitor 5000 without de-energizing the power system.

Use #14 or #12 AWG (maximum) wiring between the PowerMonitor 5000 and the shorting block. Use #14 AWG or larger wire between the shorting block and the CTs depending on the length of the circuit. Longer circuits will require larger wire so that the burden of the wiring does not overload the CT and reduce system accuracy.

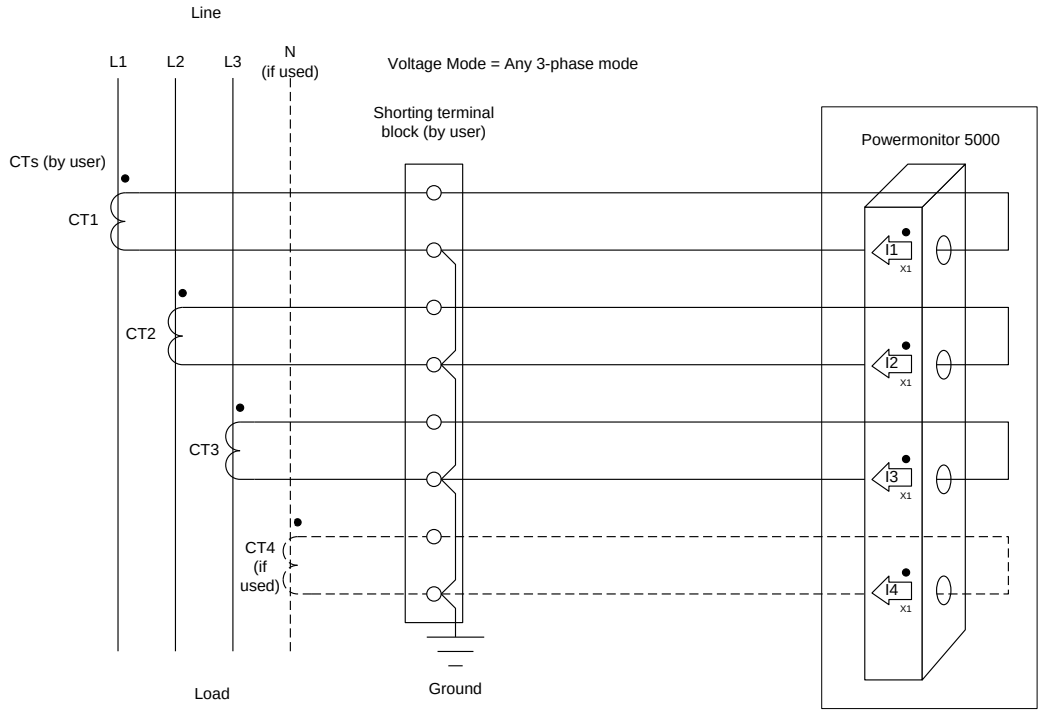
When wiring a PowerMonitor 5000 to existing CTs and metering devices, the current sensing circuits of the PowerMonitor 5000 must be wired in series with the CT secondary and current sensing circuits of the existing metering devices.

Do not install overcurrent protection or non-shorting disconnecting means in CT secondary wiring. Connect the current sensing circuit to a low-impedance earth ground at only one point.

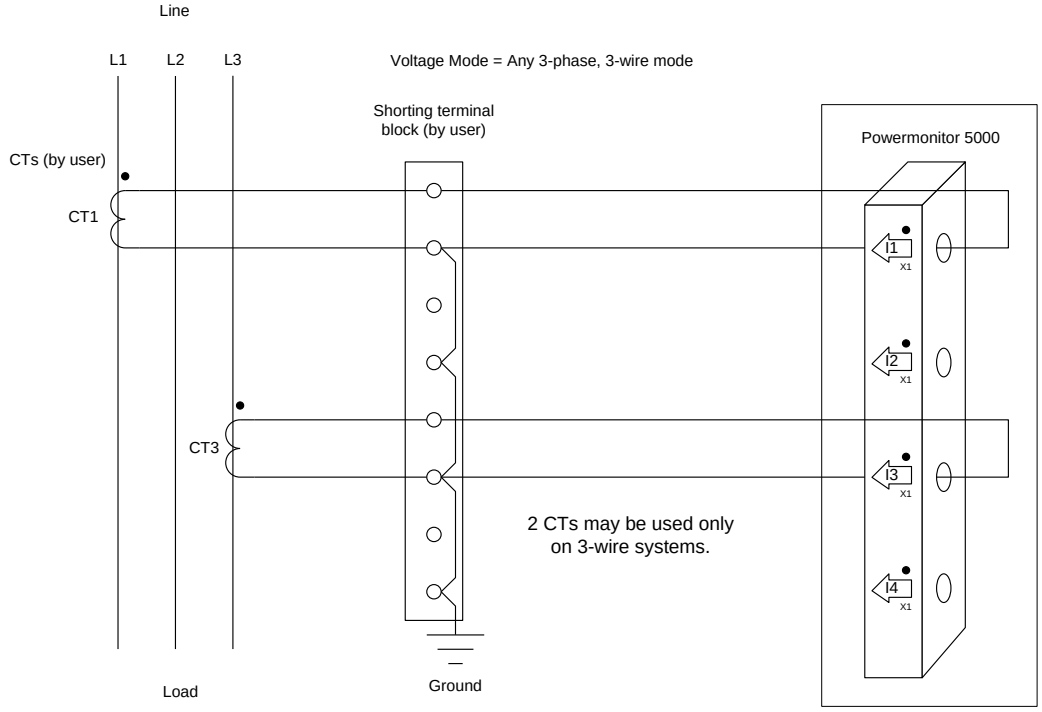
Pay particular attention to the correct phasing and polarity of current sensing connections. The diagrams use the “dot” convention to indicate transformer polarity. The dot indicates the H1 and X1 terminals on the primary and secondary of the CT respectively. Phasing of the CTs must correspond to the phasing of the voltage sensing connections.

The following wiring diagrams indicate typical current sensing connections to various types of power systems.

### Three Phase, 3- or 4-wire, 3 CTs




### Three Phase, 3-wire, 2 CTs



## B. Configuring PowerMonitor 5000 Hardware

### Connecting the PowerMonitor 5000 using the Ethernet connection

In this lab we will use the ethernet cable to connect to and configure the PowerMonitor 5000. **This section is for information only, the PM5000 is already configured.**

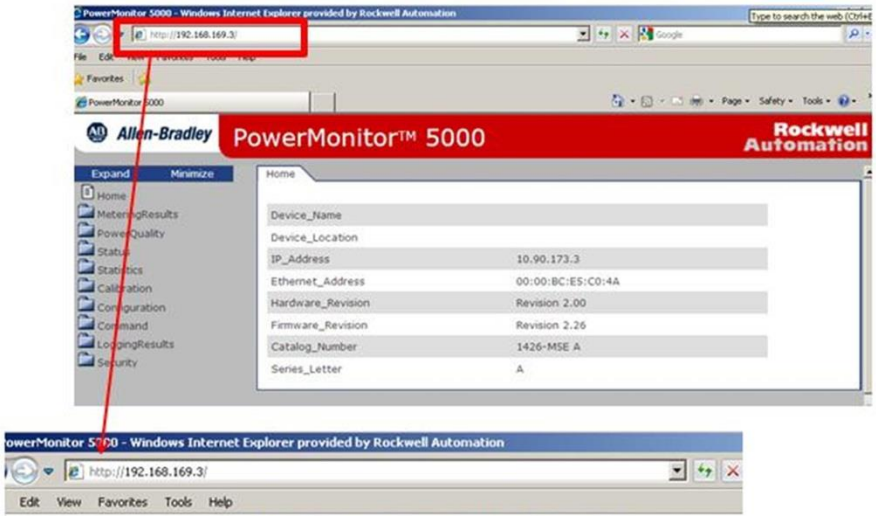
- Connect the Ethernet cable to the PM5000.

- Double-click the ***Internet Explorer – Eth PM 5000*** shortcut from the desktop of your station's PC.

- The Internet Explorer shortcut will launch Internet Explorer and open the PowerMonitor 5000 home page. The IP Address will display in the address bar as **192.168.1.5.**

- If the home page does not display when Internet Explorer opens, type **192.168.1.5** into the address bar and press the ***Enter*** key on the keyboard.

- The home page displays general information about the PowerMonitor 5000 unit. You can navigate by clicking folders and pages from the tree on the left.




- Continue with the lab to use the web interface to configure the PowerMonitor from the webpage.

### Configure the PowerMonitor 5000 using a web browser

In the field, the initial configuration is by using the power monitor's USB web interface. Once initial setup is complete, you can continue configuring the PowerMonitor 5000 unit by using either its USB or network Web interface, by using optional software, or by communicating with the power monitor's data table. In this lab we will configure the PowerMonitor 5000 using EtherNet/IP.

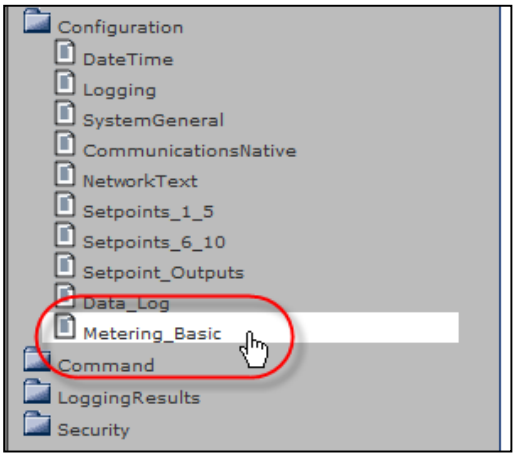
## Basic Meter Configuration

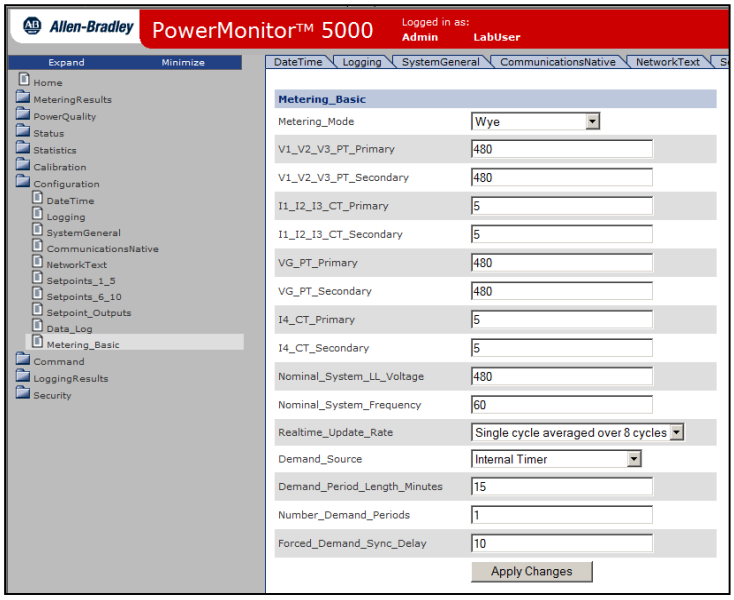
Basic metering, and all other features, can be configured through the web interface. This web interface can be accessed through both the USB device port and the IP Address. Up to this point we have done all configurations through the USB device port. We will now use the EtherNet/IP port to access the web interface and configure the basic metering for the PowerMonitor 5000.

- Select the ***Internet Explorer – PowerMonitor 5000 shortcut*** on your desktop. The PowerMonitor 5000 web interface will display in your browser with the IP Address of the PowerMonitor in the Internet Explorer address bar. If you are not directed to the web interface, type the IP Address of the PowerMonitor 5000, **192.168.1.5,** into the address bar. Click ***Enter*** and the PowerMonitor 5000 home page will display.

Navigate to the basic metering folder. From the navigation menu on the left, click ***Configuration > Metering_Basic.*** The **Metering_Basic** page displays as shown on the next page.

The **Metering_Basic** page allows us to organize basic configuration parameters of the meter. In the next few steps, we'll explore a few parameters of interest.



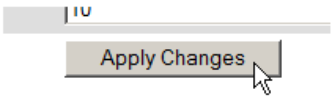


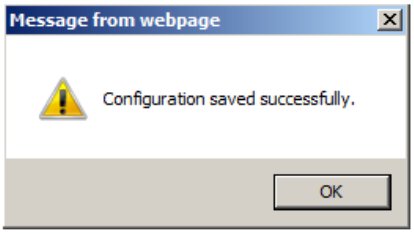

The power monitor can be wired to monitor a Wye, Delta/Open Delta, or single phase configuration. In this lab, we'll use the Wye mode. Change the Metering_Mode to Wye.

1. Change the **Voltage** values to 240 volts and the **Current** values to 5 amps.

2. Set the **Nominal_System_LL_Voltage** to 416 volts. This is equal to 240 volts times the sqrt of 3.

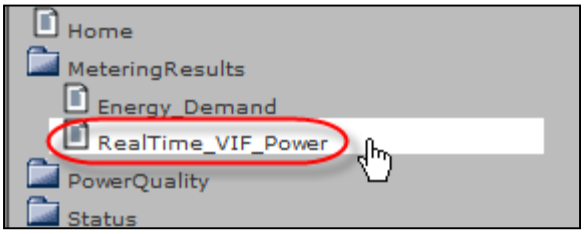
Click Apply Changes. Click OK on the confirmation pop-up after every Apply Changes action.



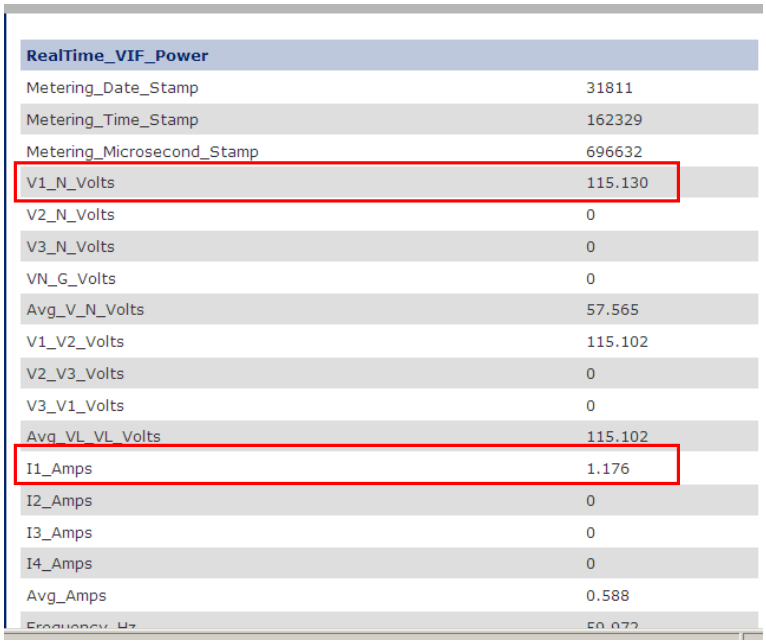




Displaying Metering Results (Data)

From the navigation menu at the left, click ***MeteringResults > RealTime_VIF_Power***.



Look over the voltage and current readings of the PowerMonitor 5000. A labeled image of the demo is shown below.



| RealTime_VIF_Power | |
|---|---|
| Metering_Date_Stamp | 31811 |
| Metering_Time_Stamp | 162329 |
| Metering_Microsecond_Stamp | 696632 |
| V1_N_Volts | 115.130 |
| V2_N_Volts | 0 |
| V3_N_Volts | 0 |
| VN_G_Volts | 0 |
| Avg_V_N_Volts | 57.565 |
| V1_V2_Volts | 115.102 |
| V2_V3_Volts | 0 |
| V3_V1_Volts | 0 |
| Avg_VL_VL_Volts | 115.102 |
| I1_Amps | 1.176 |
| I2_Amps | 0 |
| I3_Amps | 0 |
| I4_Amps | 0 |
| Avg_Amps | 0.588 |
| Frequency_Hz | 59.972 |

3. From the navigation menu at the left, click on ***Calibration > CalibrationData***

| Phase 1 | Parameter | Test Input | UUT Reading | % of Reading | Tolerance | Offset Count | Gain % |
|---|---|---|---|---|---|---|---|
| | Voltage | 347 | 347.021606 | 0.006227 | +/- 0.05 % | 1.393473 | 0.999708 |
| | Current | 5 | 5.001143 | 0.022850 | +/- 0.05 % | 4.847005 | 0.999101 |
| | Power | 1.735 | 1.735538 | 0.030994 | +/- 0.10 % | 0.000000 | 0.000000 |
| | Voltage | 120 | 120.031860 | 0.026550 | +/- 0.05 % | 8.212891 | 1.001226 |
| | Current | 2.500 | 2.500536 | 0.021448 | +/- 0.05 % | 4.847005 | 0.999101 |
| | Power | 0.300 | 0.300145 | 0.048290 | +/- 0.10 % | 0.000000 | 0.000000 |

| Phase 2 | Parameter | Test Input | UUT Reading | % of Reading | Tolerance | Offset Count | Gain % |
|---|---|---|---|---|---|---|---|
| | Voltage | 347 | 347.037231 | 0.010730 | +/- 0.05 % | 8.993083 | 0.999223 |
| | Current | 5 | 4.999979 | -0.000420 | +/- 0.05 % | -0.210286 | 0.998526 |
| | Power | 1.735 | 1.735178 | 0.010244 | +/- 0.10 % | 0.000000 | 0.000000 |
| | Voltage | 120 | 120.008972 | 0.007477 | +/- 0.05 % | 16.227783 | 1.000431 |
| | Current | 2.500 | 2.499976 | -0.000973 | +/- 0.05 % | -0.210286 | 0.998526 |
| | Power | 0.300 | 0.300019 | 0.006298 | +/- 0.10 % | 0.000000 | 0.000000 |

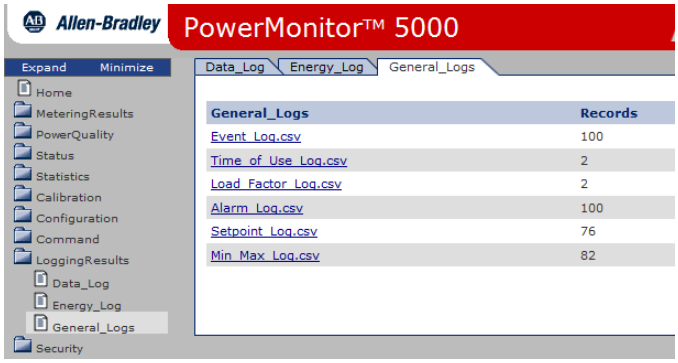
| Phase 3 | Parameter | Test Input | UUT Reading | % of Reading | Tolerance | Offset Count | Gain % |
|---|---|---|---|---|---|---|---|
| | Voltage | 347 | 347.037140 | 0.010703 | +/- 0.05 % | 6.164551 | 0.999655 |
| | Current | 5 | 5.000013 | 0.000267 | +/- 0.05 % | -1.997477 | 0.999062 |
| | Power | 1.735 | 1.735202 | 0.011646 | +/- 0.10 % | 0.000000 | 0.000000 |
| | Voltage | 120 | 120.010529 | 0.008774 | +/- 0.05 % | 11.437826 | 1.000943 |

Note: The PowerMonitor 5000 surpasses Class 0.2 Energy and Demand specifications.

Displaying Data Log

The PowerMonitor 5000 webpage publishes Energy Logs, General Logs (Event Log, Time of Use, Alarm, Min/Max. etc.) and

Data Logs *.csv format that can be downloaded.



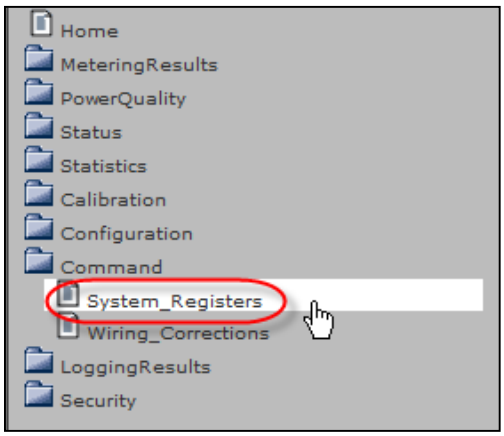

From the navigation menu at the left, click ***LoggingResults>General_Logs***. Click the ***Min_Max_Logs.csv*** link.

- Alternative File Open Method***: Right-click*** and ***Save .csv file***

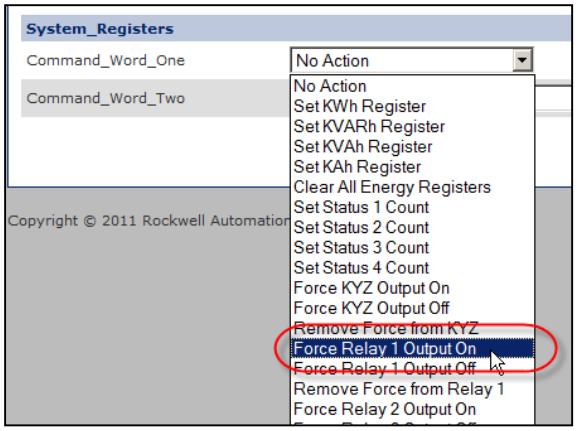
***Close*** the file after you review its content.

Commanding PowerMonitor 5000 actions

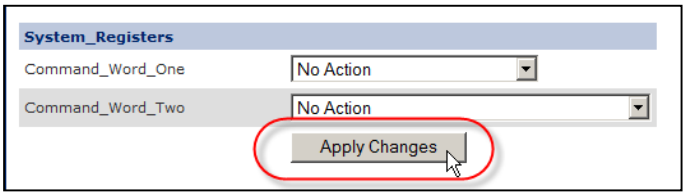
From the navigation menu at left, click ***Command > System_Registers.***




From the Command_Word_One dropdown, select ***Force Relay Output 1 On***.




Click the ***Apply Changes*** button.




Did you hear the click of the relay turn on?

From the Command_Word_One dropdown, select ***Remove Force from Relay 1***. Once selected, click the ***Apply Changes*** button.

**PLEASE DO NOT** Restore Factory Default settings. The EtherNet/IP address settings will change and you will lose communications with the unit.

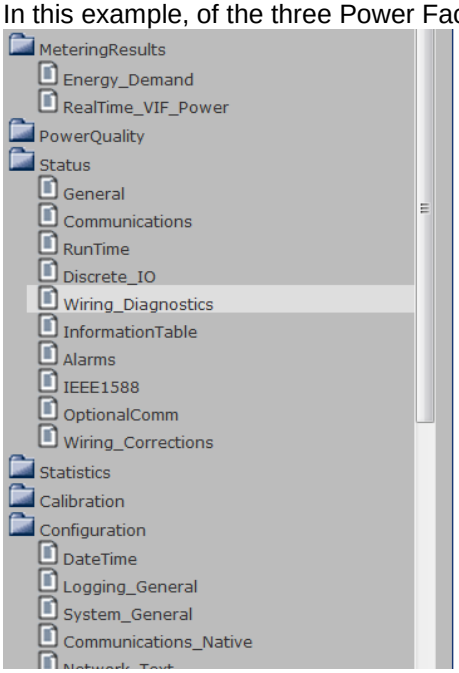
## Wiring Diagnostics

The PowerMonitor 5000 features virtual wiring diagnostics. We will be able to demonstrate wiring diagnostics in the lab as we have the power monitor wired with three phase power.

From Command > System Registers > Command Word Two, select: Perform Wiring Diagnostics.

Click Apply changes.

Go to Status > Wiring Diagnostics to view the diagnostic results.
The Command Status and other values are shown on page 55 in the PM5000 User Manual. A Zero value is a Command Active or Test Passed.
In this example, of the three Power Factor Ranges, two passed.

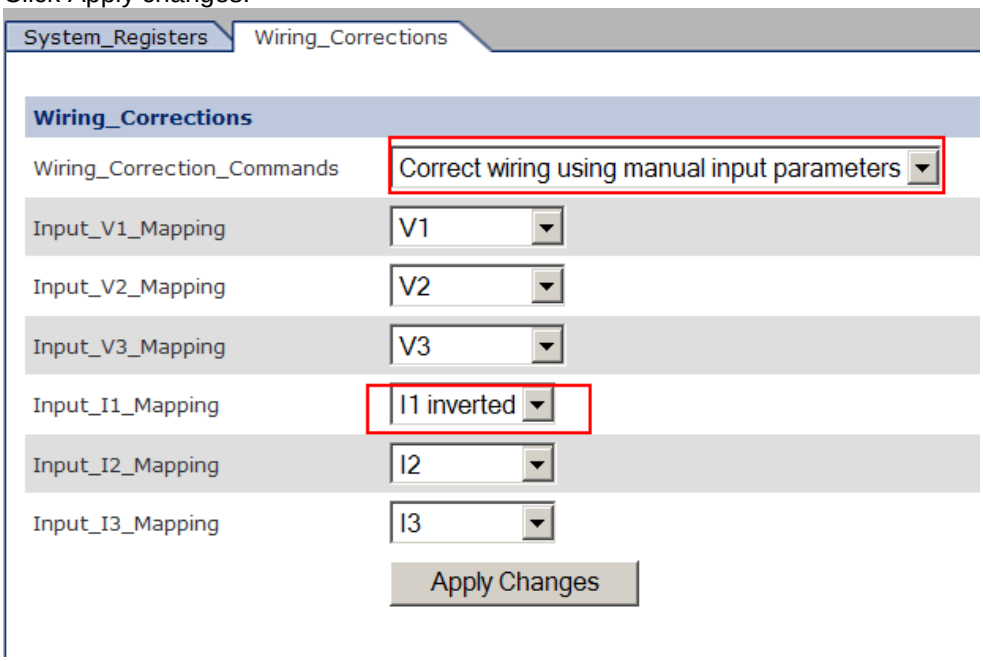



| Wiring_Diagnostics | |
|---|---|
| Command_Status | 0 |
| Voltage_Input_Missing | 0 |
| Current_Input_Missing | 0 |
| Range1_L97_C89_Status | 1 |
| Range1_Voltage_Input_Inverted | 0 |
| Range1_Current_Input_Inverted | 0 |
| Range1_Voltage_Rotation | 123 |
| Range1_Current_Rotation | 5 |
| Range2_L85_C98_Status | 0 |
| Range2_Voltage_Input_Inverted | 0 |
| Range2_Current_Input_Inverted | 0 |
| Range2_Voltage_Rotation | 123 |
| Range2_Current_Rotation | 123 |
| Range3_L52_L95_Status | 0 |
| Range3_Voltage_Input_Inverted | 0 |
| Range3_Current_Input_Inverted | 0 |
| Range3_Voltage_Rotation | 123 |
| Range3_Current_Rotation | 123 |

## Wiring Correction

The PowerMonitor 5000 features virtual wiring correction. We will be able to demonstrate wiring diagnostics in the lab as we have the power monitor wired with three phase power.

From Command > Wiring _Correction > Wiring Correction Command ,select: Correct wiring using manual input parameters.
Change Input I1 Mapping to I1 inverted.
Click Apply changes.




Verify the virtual wiring correction LED is illuminated on the PM5000.

From the navigation menu at left, click Status>Wiring_Correction to verify Input_I1_mapping reads “-1”. This confirms the polarity of current Input_I1 has been properly inverted and saved successfully.

You may also view the MeteringResults > RealTime_VIF_Power. Page and note that the L1_kW and Total_kW are now negative.

| Wiring_Corrections | |
|---|---|
| Wiring_Correction_Commands | 4 |
| Input_V1_Mapping | 1 |
| Input_V2_Mapping | 2 |
| Input_V3_Mapping | 3 |
| Input_I1_Mapping | -1 |
| Input_I2_Mapping | 2 |
| Input_I3_Mapping | 3 |
| Last_Cmd_Rejection_Status | 0 |
| Rejection_Information | 0 |

Return to the Command > Wiring_Corrections page. Remove the wiring correction. Select: Remove all wiring correction. Click Apply changes.

Verify the virtual wiring correction LED is not illuminated on the PM5000.

## C. Configuring FactoryTalk EnergyMetrix Software

This part of lab also uses the VMImage

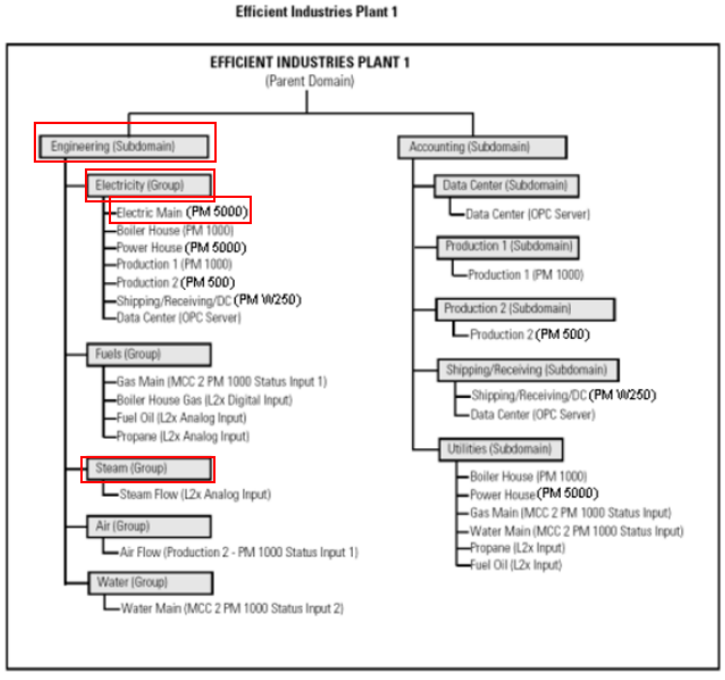
> This part of the hands-on lab will briefly introduce you to the FactoryTalk EnergyMetrix web interface and how to use it to configure a FactoryTalk EnergyMetrix system. You will first create domains and groups, then configure devices (PowerMonitor 5000, ControlLogix via RSLinx Classic OPC) and meters, view trends/calendar trends and then configure and run Consumption/'Billing Reports in different currencies/Pareto reports and Custom Reports using Excel.

### Set up Groups and Domains in a FactoryTalk EnergyMetrix project

A typical setup is to organize meters into domain groups by energy type, substation, boiler room, or other function. A second domain is then set up to organize meters into energy accounting groups.

- **Group** - A named collection of devices and meters that represent a subdivision of your enterprise such as a department or process.
- **Domain** - A group that is assigned roles and users. Users assigned to a domain may only access objects assigned to that domain. This allows an administrator to restrict user access to specific parts of the system.

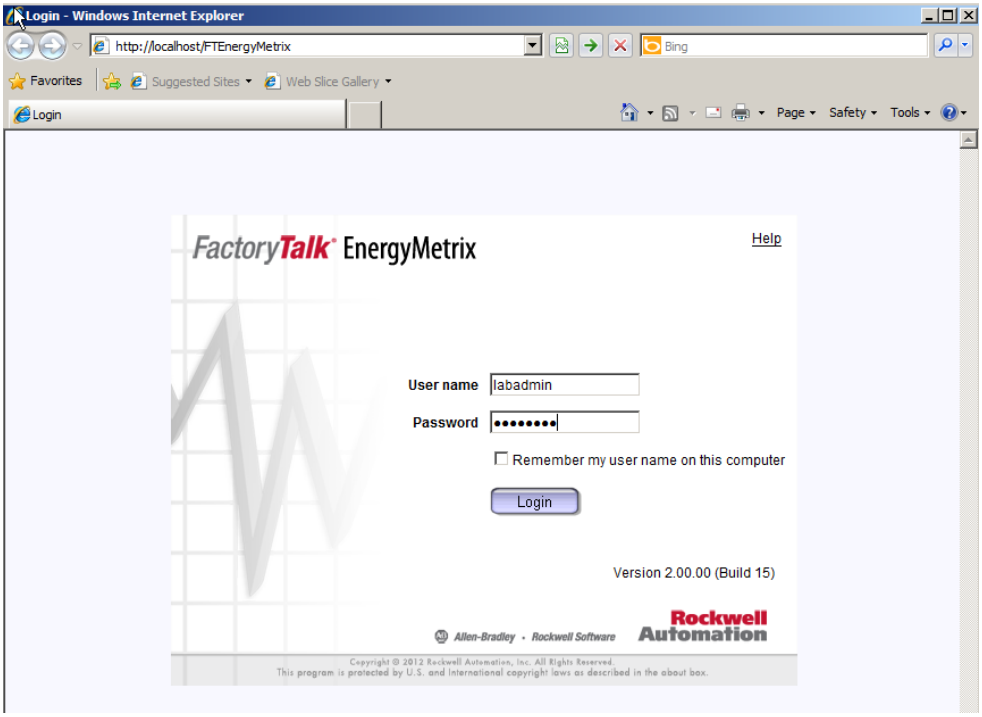
This lab will setup the FactoryTalk EnergyMetrix project for Efficient Industries Plant 1. Only a few selected Groups and Domains will be added for Efficient Industries Plant 1.


Efficient Industries Plant 1
EFFICIENT INDUSTRIES PLANT 1
(Parent Domain)
Engineering (Subdomain)
Electricity (Group)
Electric Main (PM 5000)
Boiler House (PM 1000)
Power House (PM 5000)
Production 1 (PM 1000)
Production 2 (PM 500)
Shipping/Receiving/DC (PM W250)
Data Center (OPC Server)
Fuels (Group)
Gas Main (MCC 2 PM 1000 Status Input 1)
Boiler House Gas (L2x Digital Input)
Fuel Oil (L2x Analog Input)
Propane (L2x Analog Input)
Steam (Group)
Steam Flow (L2x Analog Input)
Air (Group)
Air Flow (Production 2 - PM 1000 Status Input 1)
Water (Group)
Water Main (MCC 2 PM 1000 Status Input 2)
Accounting (Subdomain)
Data Center (Subdomain)
Data Center (OPC Server)
Production 1 (Subdomain)
Production 1 (PM 1000)
Production 2 (Subdomain)
Production 2 (PM 500)
Shipping/Receiving (Subdomain)
Shipping/Receiving/DC (PM W250)
Data Center (OPC Server)
Utilities (Subdomain)
Boiler House (PM 1000)
Power House (PM 5000)
Gas Main (MCC 2 PM 1000 Status Input)
Water Main (MCC 2 PM 1000 Status Input)
Propane (L2x Input)
Fuel Oil (L2x Input)

- **Engineering** - includes all of the energy data points and is subdivided into energy types for load profiling, consumption reporting, and power quality monitoring needs.
- **Accounting** - organized into production, and shipping/receiving departments for cost allocation analysis. This group also includes a utilities subgroup for nonproduction cost allocation analysis and utility shadow billing.

1. ***Open*** Internet Explorer. The FactoryTalk EnergyMetrix login page is set up as the home page <http://localhost/FTEnergyMetrix>. Log in with user name: **labadmin** and password: **rockwell**

   - This login gives you administrator access to the Efficient Industries Plant 1 domain.




   - Once you log in,there are four tabs on the navigation pane. Each tab is described below.

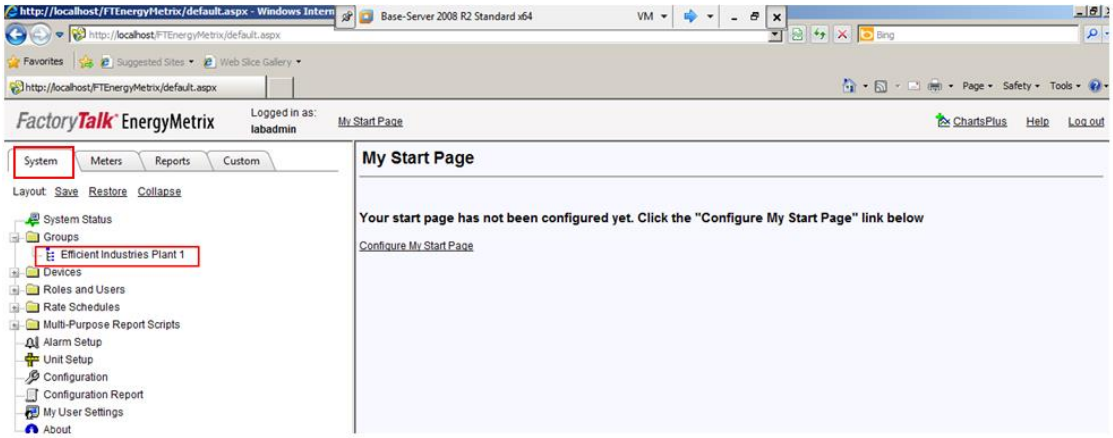
**System**: Allows Configuration for Groups/Domain (tree structure), Devices, Roles and Users, Rache Schedules, Custom Reports (Multi-Purpose Reports, My Start Page and other setups (i.e Units, User settings, Alarm sub scriptions)

**Meters**: Allows to Configure Meters and meter tags, and to view Meter data in tabular /Trend and Calendar Trend

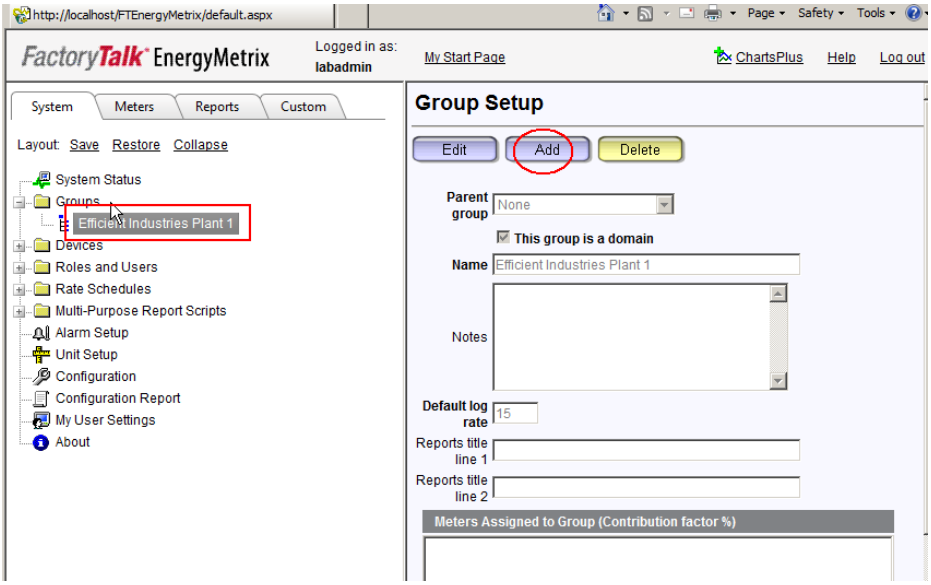
**Reports:** Allows to Configure Reports, automatic report jobs, and to generate/view reports on demand

**Custom:** Allows to Configure custom page( with URL Link, for Files (i.e. user can upload a scanned copy of Utility Energy Bill to Custom page)

> Note: The right View Pane is updated only after a sub category is selected of any given tab/(Tree Item).

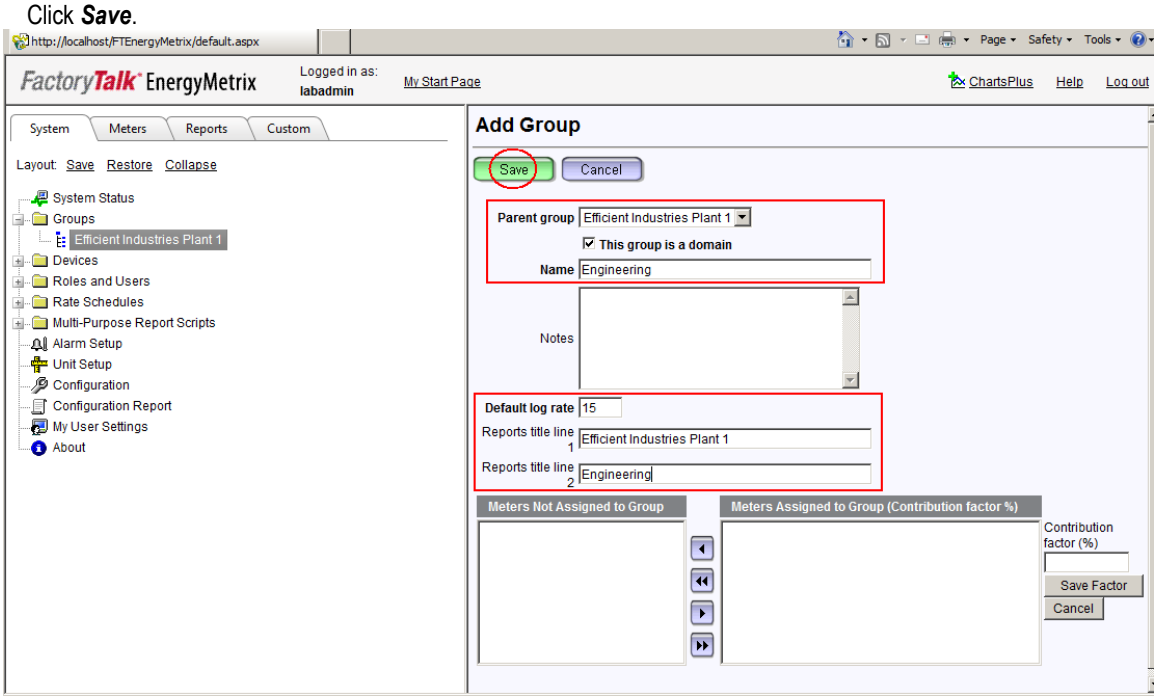



2. Select the Parent Domain "***Efficient Industries Plant 1***" under "Groups" and click ***Add***.



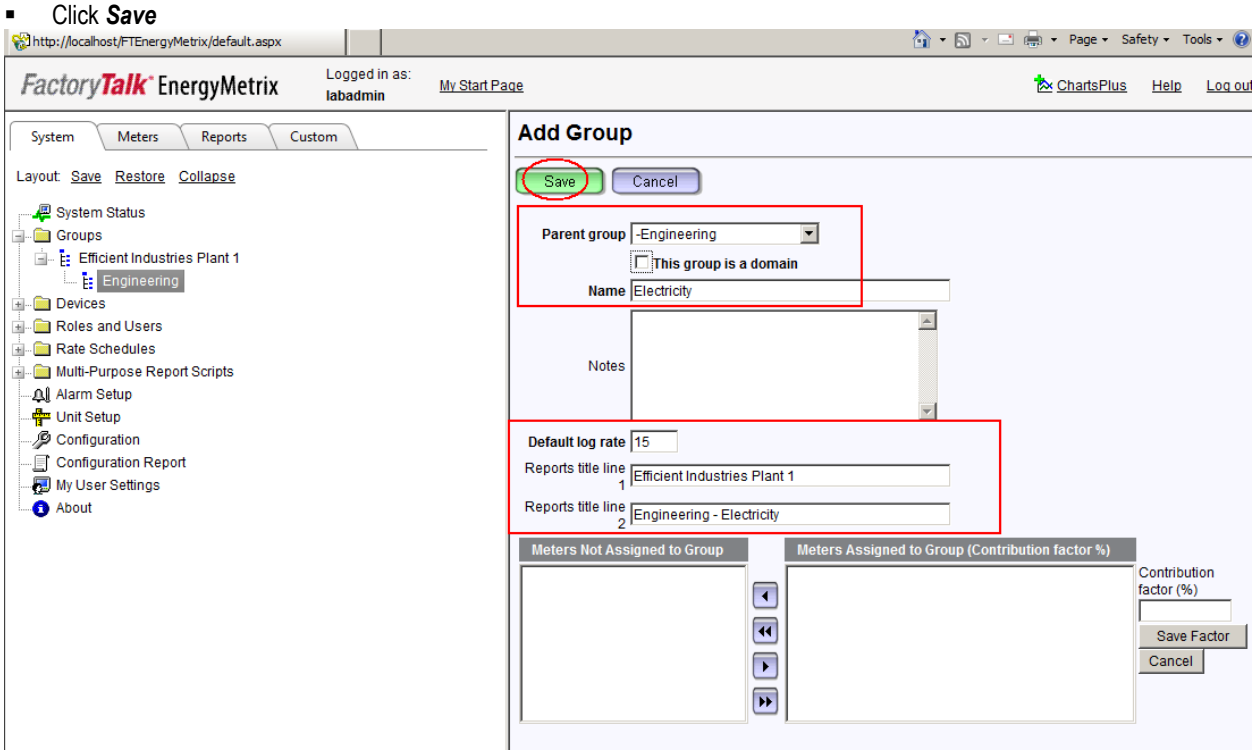
3. Create an “Engineering” Domain in the “Efficient Industries Plant 1” Domain

- Click on ***Efficient Industries Plant 1*** and Click ***Add***
- Select ***Efficient Industries Plant 1*** as the Parent Group
- Check “***This group is a domain***”
- Type in ***Engineering*** as the ***Name***
- Insert ***15*** for the ***Default log rate***
- Type ***Efficient Industries Plant 1*** for ***Report title line 1***
- Type ***Engineering*** for ***Report title line 2***
- Click ***Save***.



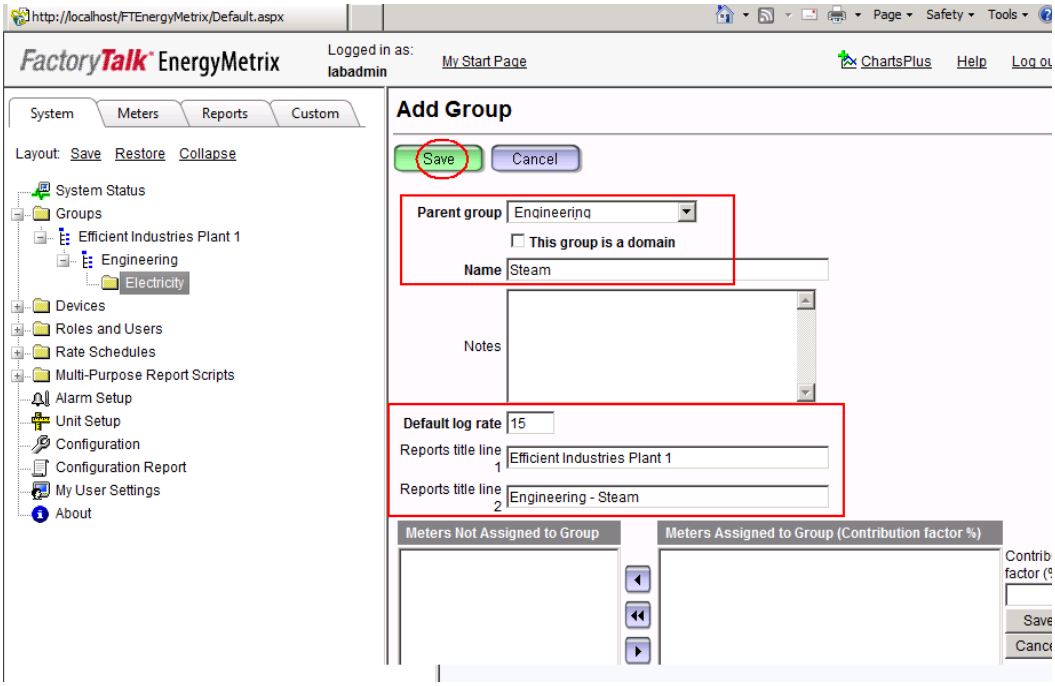
4. Create an “Electricity” Group in the “Engineering” Sub Domain

   - Under ***Groups***, click on the ***Engineering*** sub domain under ***Efficient Industries Plant 1*** and click ***Add***
   - Select ***Engineering*** for the ***Parent Group***
   - Do ***NOT*** Check “This group is a domain”
   - Enter ***Electricity*** for the ***Name***
   - Enter ***15*** for the ***Default log rate***
   - Enter ***Efficient Industries Plant 1*** for the ***Report title line 1***
   - Enter ***Engineering - Electricity*** for the ***Report title line 2***
   - Click ***Save***




5. Create a “Steam” Group in the “Engineering” Sub Domain

   - Under ***Groups***, click on the ***Engineering*** sub domain under ***Efficient Industries Plant 1*** and click ***Add***
   - Select ***Engineering*** as the ***Parent Group***
   - Do ***NOT*** Check “This group is a domain
   - Enter ***Steam*** as the ***Name***
   - Enter ***15*** for the ***Default log rate***
   - Enter ***Efficient Industries Plant 1*** for the ***Report title line 1***
   - Enter ***Engineering – Steam*** for the ***Report title line 2***
   - Click ***Save***




**Set up Devices and Meters in a FactoryTalk EnergyMetrix project**

Devices are physical entities that FactoryTalk EnergyMetrix communicates with over a network. Setting up a device in FactoryTalk EnergyMetrix establishes communication and creates database definitions for the device.

Devices may be directly connected to the server over a network if the FactoryTalk EnergyMetrix server is also on the network through an appropriate network interface and you have configured the appropriate RSLinx Classic device drivers. Devices routed through a ControlLogix gateway or RSLinx Classic gateway are also considered directly connected devices.

FactoryTalk EnergyMetrix uses device classes to determine how to interact with a particular device. The device class includes the device family, communication type, and specifies whether the device has a clock that can be synchronized.

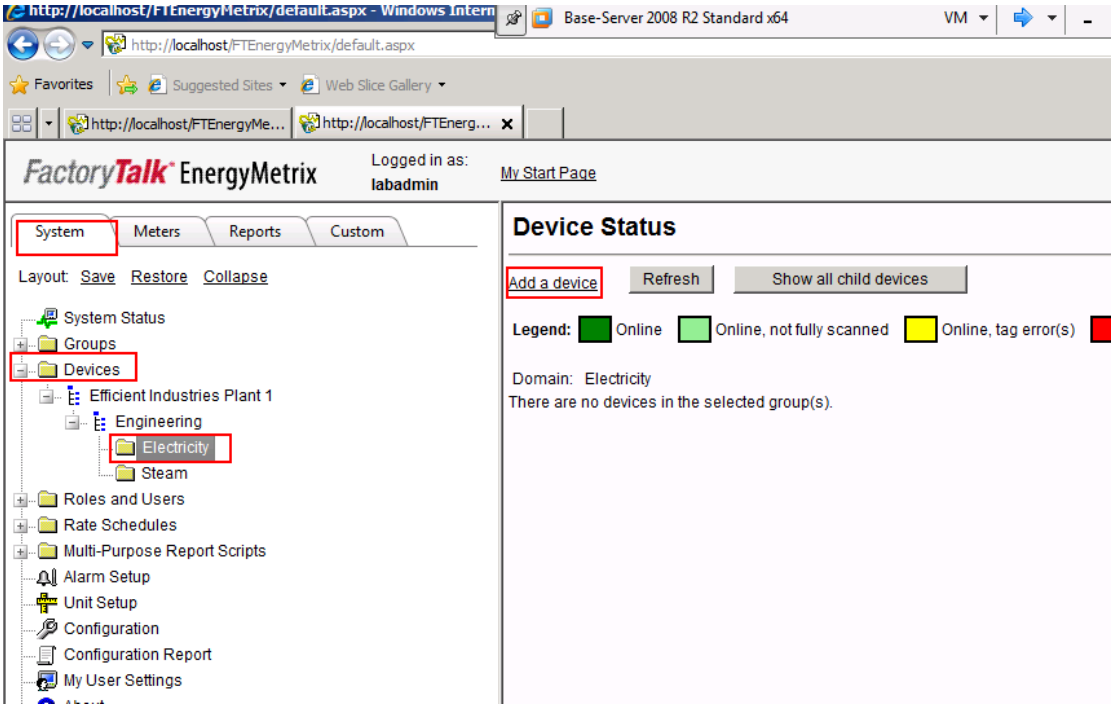
Examples of supported device classes in FactoryTalk EnergyMetrix are listed below. PowerMonitor 5000 and OPC Server on Ethernet devices will be demonstrated in the next lab steps.

- **PowerMonitor 5000 device**
- PowerMonitor 1000 device
- PowerMonitor 500 device
- PowerMonitor (wireless) W250 device
- PowerMonitor 3000 device
- ControlLogix or CompactLogix controller
- FactoryTalk Live Data Server on Ethernet – NEW with FactoryTalk EnergyMetrix
- **OPC Server on Ethernet**

**Meters in a FactoryTalk EnergyMetrix project are the tag addresses and datatypes in the Devices.**

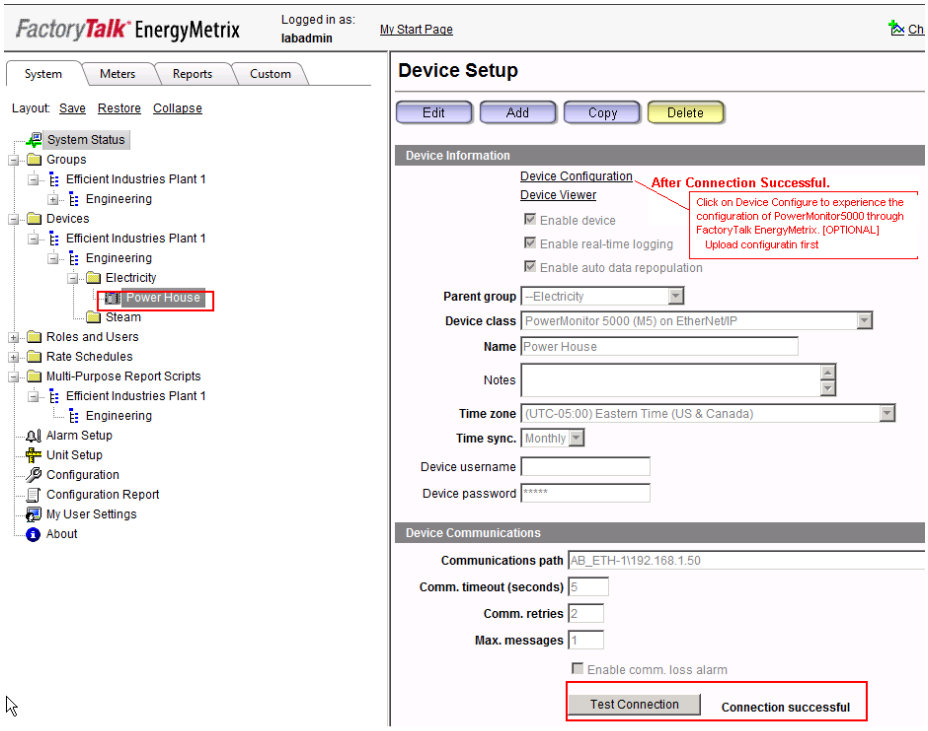
1. Add PowerMonitor 5000 to Efficient Industries Plant 1 > Engineering > Electricity Group

In the System tab, click Devices then Efficient Industries Plant , then Engineering and exapnd the tree and click on Electricity. From the Right View Pane click Add a device



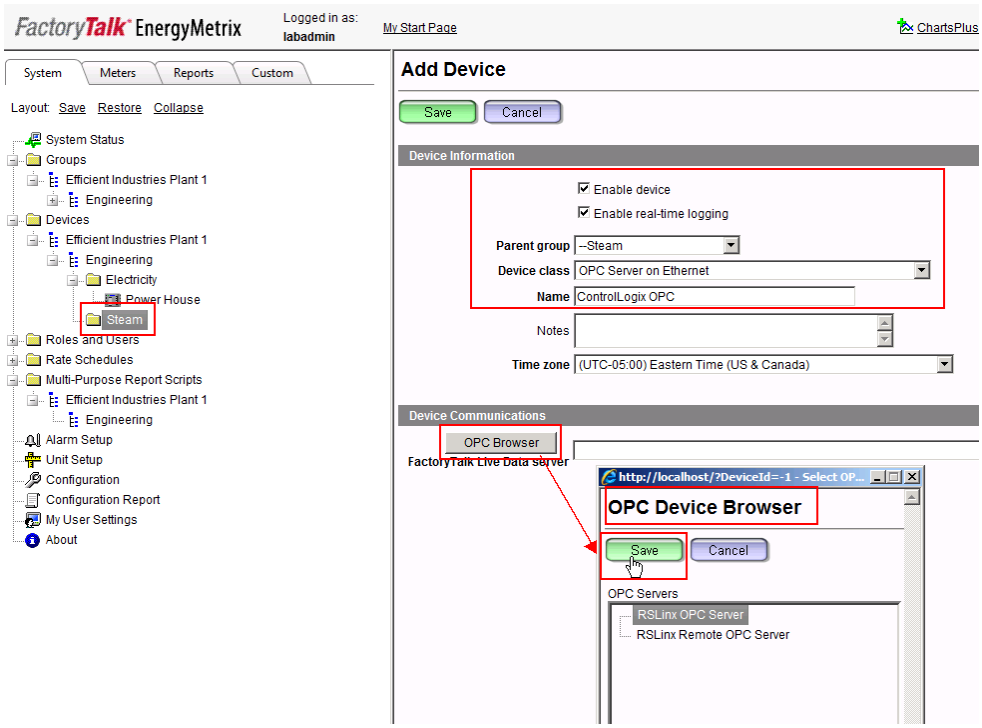

- Once the device configuration displays in the right view pane, select ***Electricity*** for the ***Parent Group***
- Select ***PowerMonitor5000 (M5) on EtherNet/IP*** for the Device Class
- Enter ***Power House*** as the Name
- Leave the ***Device User name/Password*** blank. Security is not eabled for this lab
- Check ***Enable device***, ***Enable real-time logging***, and ***Enable auto data repopulation***
- Enter ***AB_ETHIP-1\192.168.1.5*** for the Communication path
- Click ***Save***

2. Click on ***Test Connection*** and Verify Connection Successful. Perform the test connection three more times to ensure the first test did not reflect a cache status.




3. Add an OPC Device

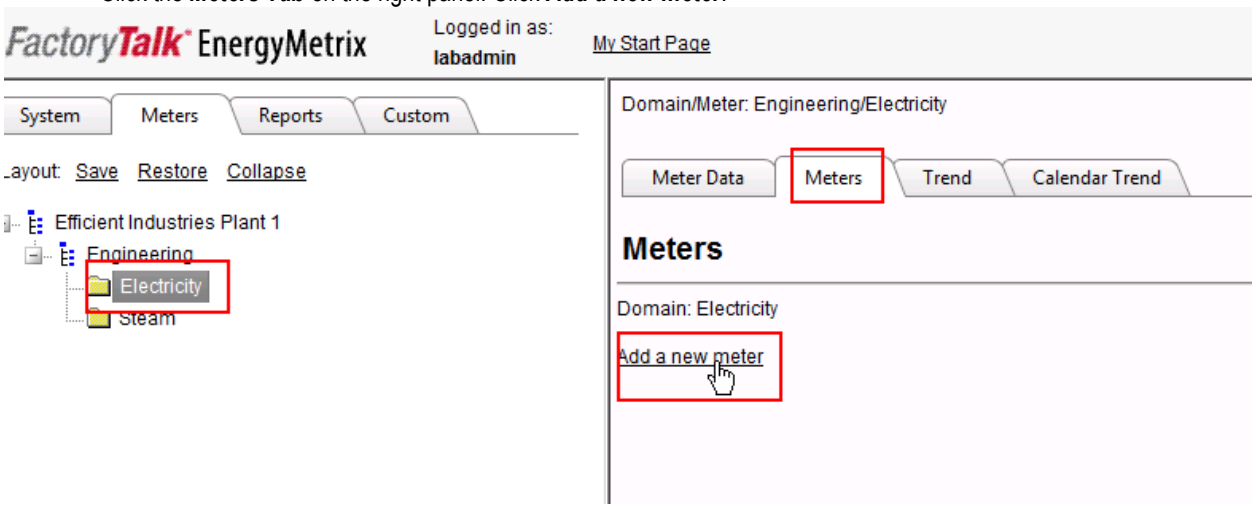
- Click on the ***System Tab***. Navigate to ***Devices*** and select ***Steam*** under the ***Engineering subdomain***.
- Click ***Add a device***. Select ***OPC Server on Ethernet*** for the Device class.
- Enter ***ControlLogix OPC*** for the Name and ensure the Parent group is ***Steam***. Check ***Enable Device and Enable real-time logging.***
- Click ***OPC Browser*** and a window will pop-up. Select ***RSLinx OPC server*** then click ***Save***.
- The Server should now show under Device Communications. Click ***Save*** to add the device.



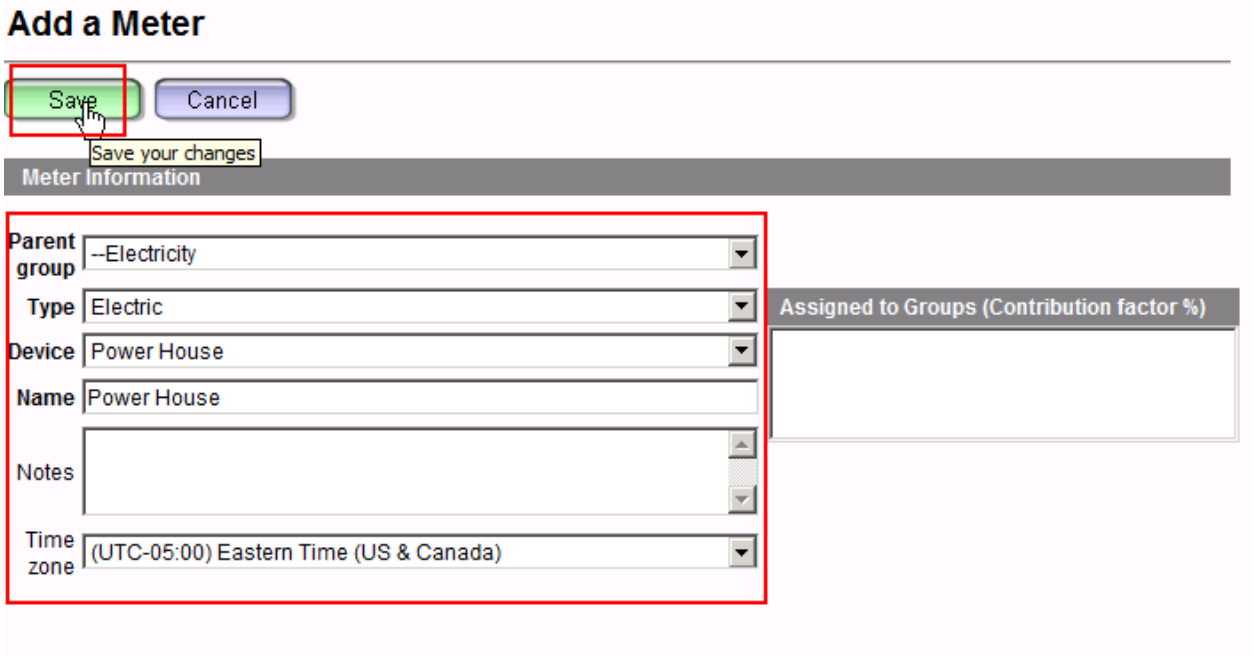

**Setting up PowerMonitor 5000 and ControlLogix OPC Meters**

1. Create the PowerMonitor 5000 Meter

   - Select the ***Meters Tab***. Navigate to the ***Electricity Group*** under ***Engineering***
   - Click the ***Meters Tab*** on the right panel. Click ***Add a new meter***.

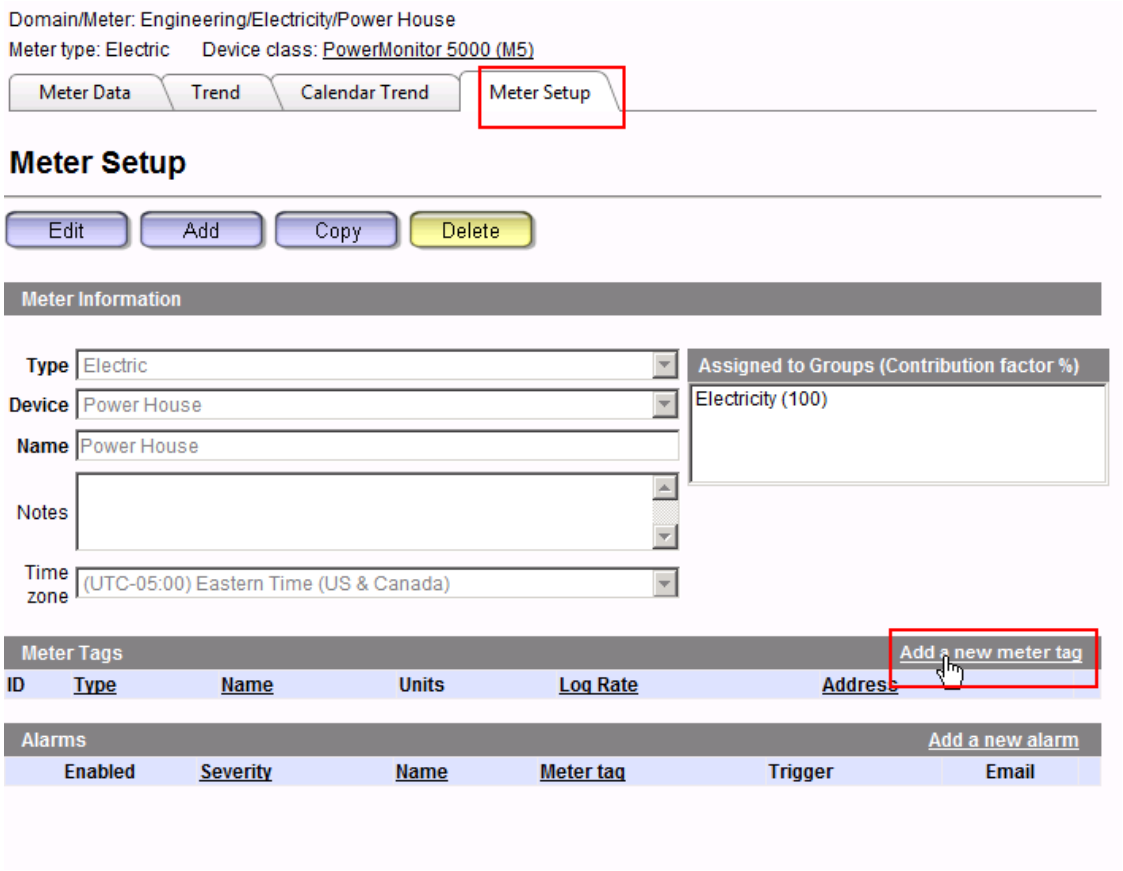



   - Change the Type from Manual to ***Electric***. For the Device select ***Power House*** (a PowerMonitor 5000).
   - Enter ***Power House*** as the ***Name***. Select appropriate time zone.
   - Click ***Save***.

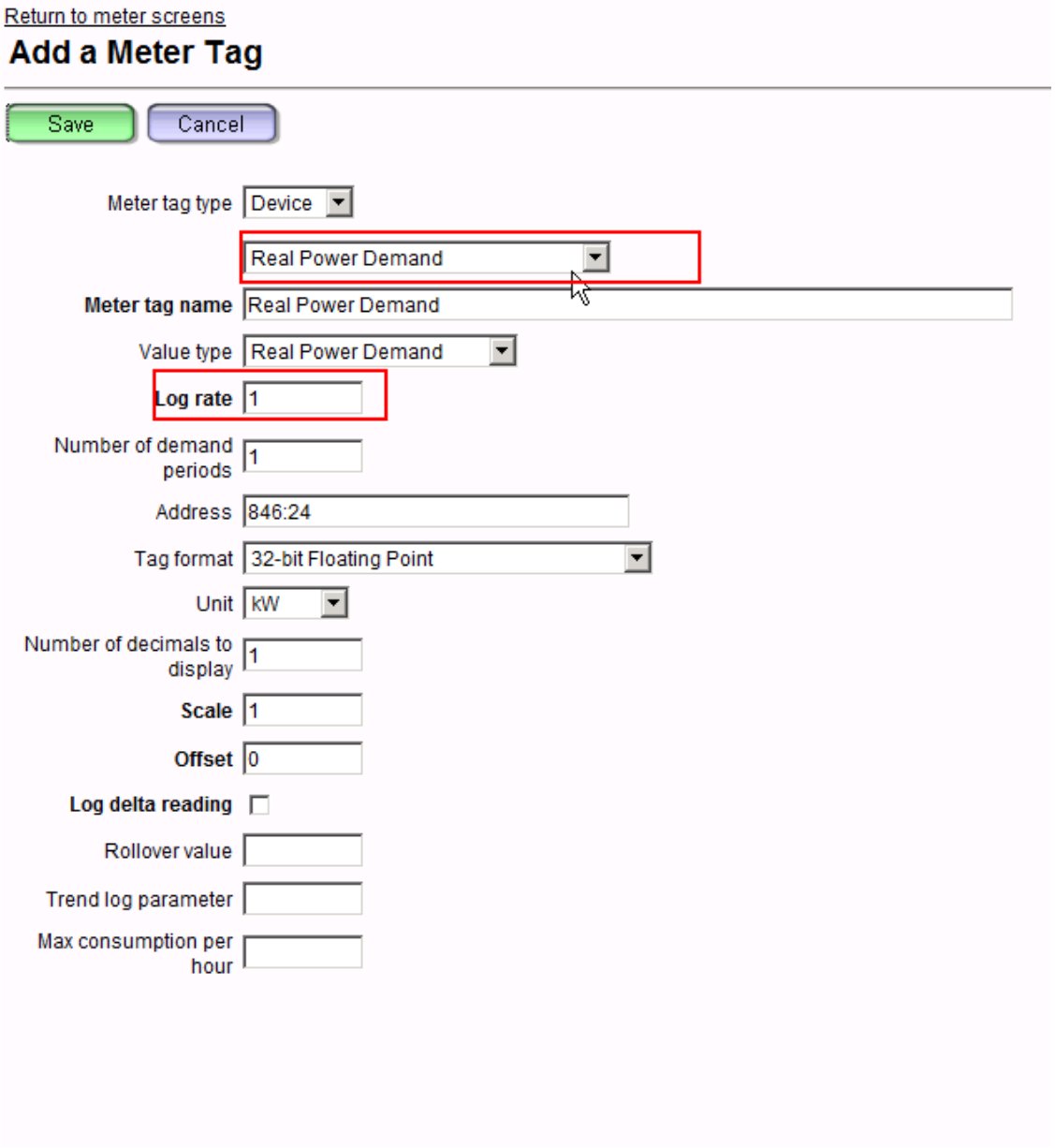



2. Add Meter Tags

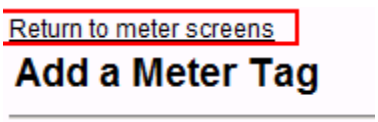
   - Click the ***Meter Setup*** Tab. Click ***Add a new meter tag***.



3. Select ***device tag*** to load data from the dropdown menu. Select ***Real Power Demand***.
    - Change the ***log rate to 1 minute*** in order to capture data for this lab. The default is 15 minutes for logging.

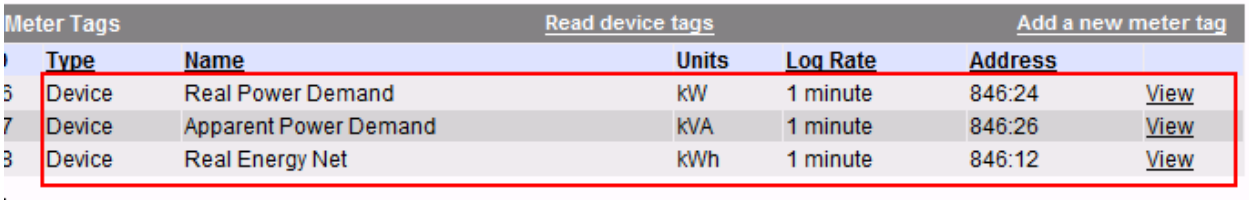



4. Click ***Save***. Click ***Add*** to add the following tags: ***Real Energy Net*** and Apparent Power Demand both with 1 minute log rates.
    - Click on Return to meter screens after adding the tags

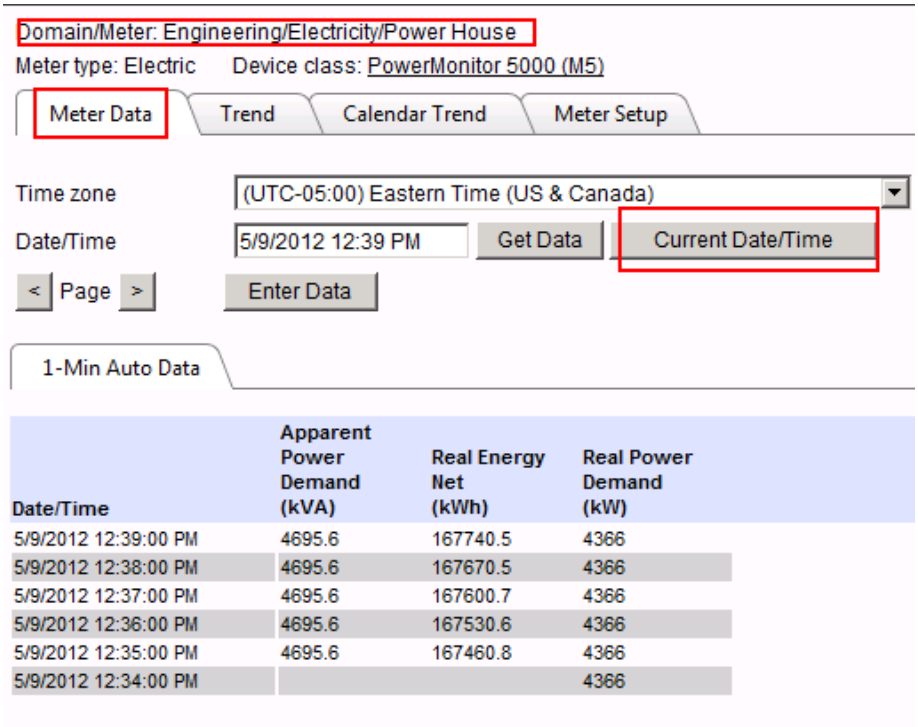


5. When you return to meter set up, the tags should be displayed as shown below. Click ***Read device tags*** to open up a new window. Click ***Refresh*** to ensure that the tags are being updated.

   - Click ***Refresh*** again if Status shows as NS (not scanned). It may take couple clicks(few seconds) for the data to start updating.

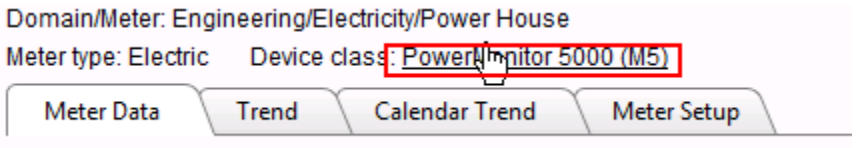


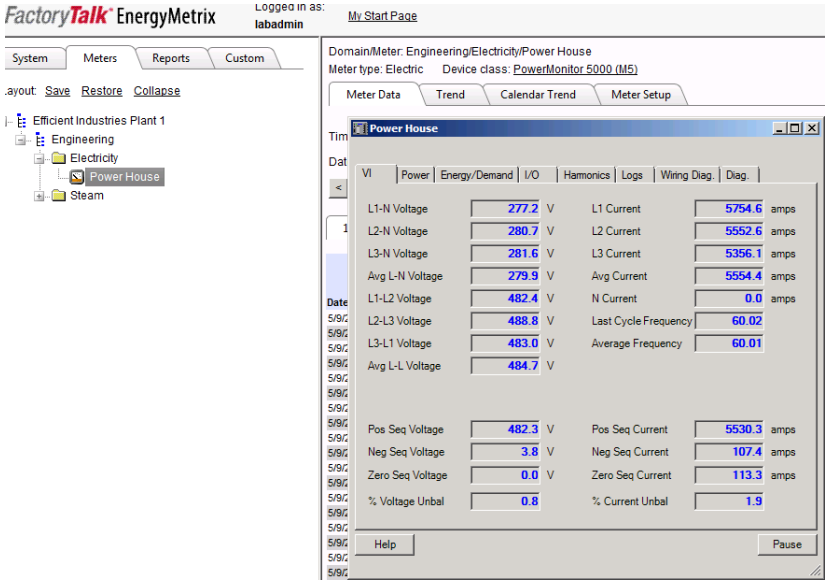

6. Click on the ***Meter Data*** Tab and click ***Current Date/Time***. Verify the data is logged.




7. Click on the ***PowerMonitor 5000 (M5)*** link on the top of Power House Meter screen

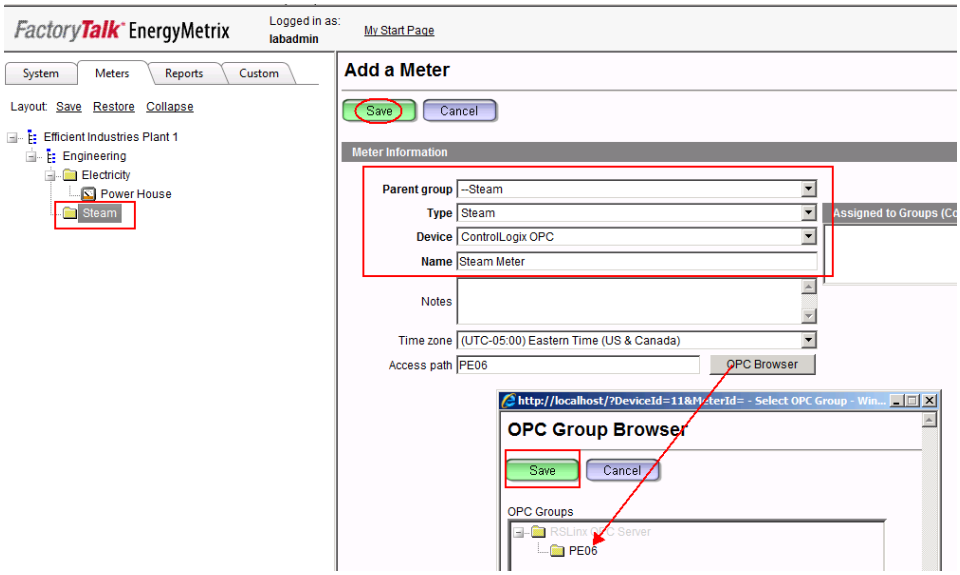
   - Verify the Power House Meter is udpating PowerMonitor 5000 metering data.
   - Click on the ***I/O tab***. Under Relays click ***Close*** or ***Open Relays***. Did you hear anything?
   - ***Close*** the Power House Realtime window.





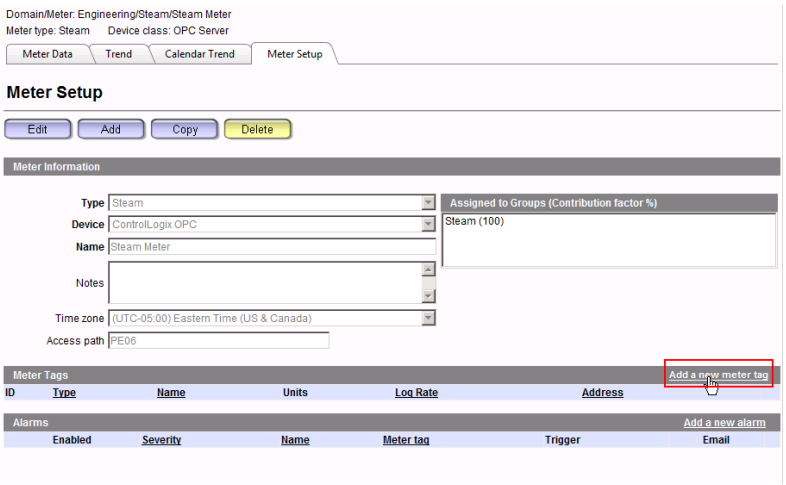

8. Create the OPC Meter (ControlLogix OPC)

   - Select the ***Meters*** Tab. Navigate to the ***Steam Group*** under ***Engineering***.
   - Click the ***Meters*** Tab on the right panel. Click ***Add a new meter***.
   - Change the ***Type*** from Manual to ***Steam***. For the Device select ***ControlLogix OPC***.
   - Enter ***Steam Meter*** as the Name. Select appropriate time zone.
   - Click ***OPC Browser*** and Select ***PE06 to the CompactLogix***.
   - Click ***Save***.

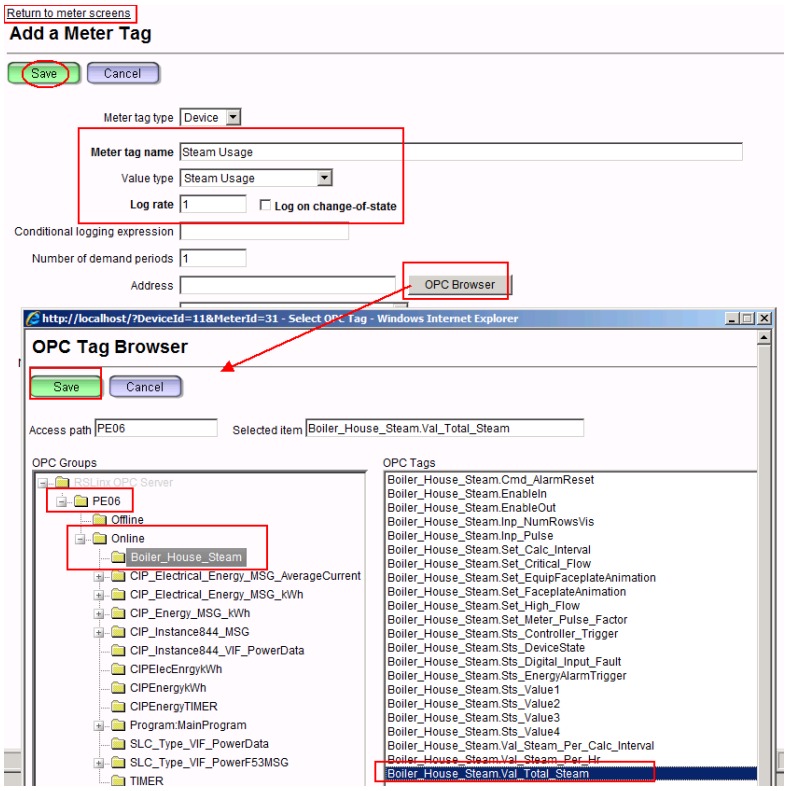



9. Click ***Save*** to save Steam Meter.
10. Add Meter Tags for the Steam Meter.

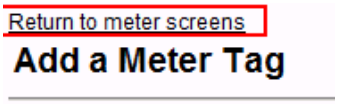
    - Click the ***Meter Setup*** Tab. Click ***Add a new meter tag***



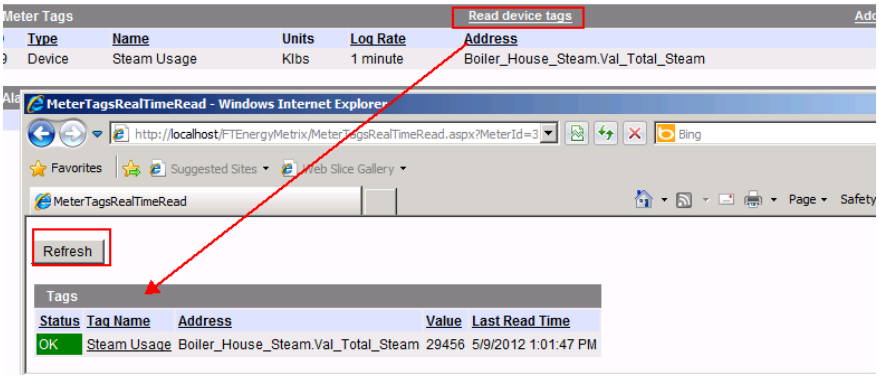

- Type ***Steam Usage*** as the Meter Tag name
- Select ***Steam Usage*** for the ***Value Type***
- Change the ***Log rate*** to 1
- Click on ***OPC Browser*** to select the ***Boiler_House_Steam.Val_Total_Steam*** tag from the OPC Tag Browser pop up window as shown in the screenshot below. Click ***Save*** in the OPC Tag Browser.
- Click ***Save***



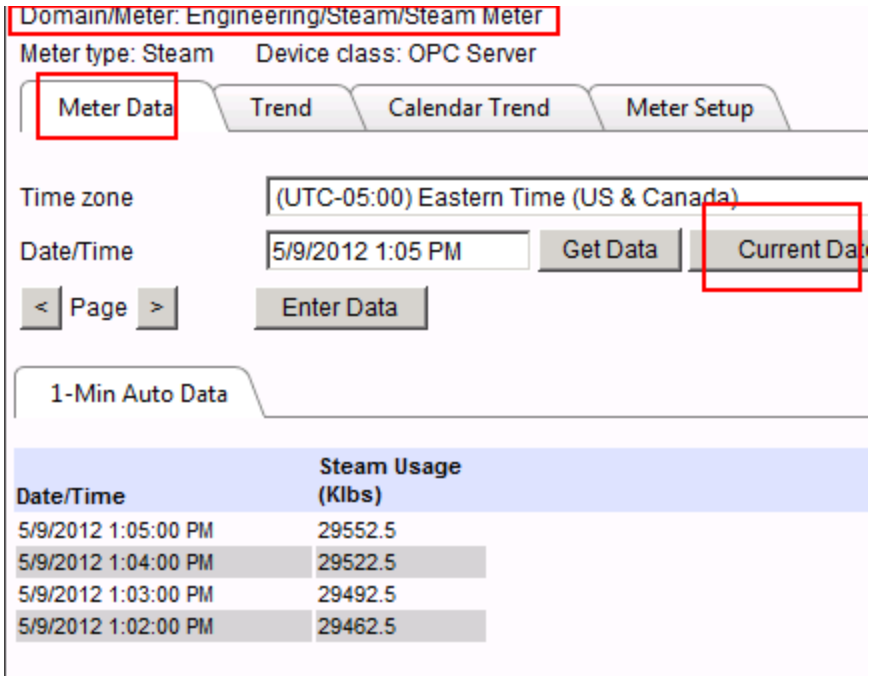

11. Click on ***Return to meter screens*** after adding the tags



12. Click ***Read device tags*** to open up a new window. Click ***Refresh*** to ensure that the tags are being updated.
    - Click ***Refresh*** again if the statusshows as NS (not scanned). It may take couple clicks(few seconds) for the data to start updating.




13. Click on the ***Meter Data*** Tab and click ***Current Date/Time***. Verify the data is being logged.





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